Original Article

Osteoporotic hip fractures in low-income group population, hospital based case control study from India

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Abstract

Context: Osteoporosis is a public health problem in India with high incidence of fractures. **Aim:** The aim of the study w to know the profile of bone parameters and its factors associated with hip fractures in osteoporotic men and women living in low socioeconomic conditions. **Settings and Design:** A hospital-based case-control study was carried out in Orthopedics ward of the Osmania General Hospital (OGH), Hyderabad, Andhra Pradesh, India. **Materials and Methods:** A total of 72 men and 72 women aged 35-70 years admitted in OGH with hip fractures during April 2005 to March 2008 were recruited. Age, gender and socioeconomic background matched controls (men: 72 and women: 46) living in Hyderabad were employed. Clinical examination, bone mineral density (BMD), anthropometric measurements, and biochemical markers of bone metabolism were analyzed. **Statistical Analysis Used:** Descriptive and inferential statistics were carried using SPSS. **Results:** The mean age of men with fractures was 59.1 ± 9.42 years while, in women, it was 63.6 ± 9.97 years. BMD at the hip ($P < 0.001$) and calcium ($P < 0.05$), Vitamin D ($P < 0.001$), total alkaline phosphatase levels ($P < 0.05$) were significantly lower in the cases. While, paratharmone activity and urinary calcium excretion ($P < 0.001$) were found to be high in cases compared to controls. Gender, body mass index, serum Vitamin D explained variation in BMD at all the sites. **Conclusion:** The high prevalence of Osteoporotic fracture rates in Indians at an early age compared to developed countries highlights the need for dietary diversification, physical activity, self-care management, among the low-income group population to reduce the risk of osteoporosis and its associated risk factors.

Key words: Bone parameters, fractures, osteoporosis, risk factors

INTRODUCTION

Osteoporosis is a major public health problem due to its devastating health outcomes and a high incidence of fractures.[1] It is a global health problem and socio-economic burden in developed as well as developing countries among both affluent and nonaffluent societies.[2] It is expected that by 2050, half of the hip fractures may occur in Asia.[3] Osteoporosis is widely prevalent in India and 20% women and 10-15% men were found to be osteoporotic.[4] In most Western countries, the peak incidence of osteoporotic fractures occur at the age of 70-80 years, but in India, these fractures occur 10-20 years earlier in their 50 s and of major concern due to its associated morbidity and mortality.

Among the osteoporotic fractures, 20%[5] were hip fractures and these were serious because of their postfracture mortality of 8-33%.[6] Osteoporotic hip fractures occur due to minimal trauma[7] and are strongly related to the low bone mineral density (BMD). BMD is the main determinant of bone fragility leading to hip fractures.[8] Hip BMD was more strongly correlated with hip fractures than the lumbar spine or peripheral BMD measurements.[9]

Studies show that low socioeconomic populations in India suffer from poor bone health and a high prevalence of osteoporosis which leads to early fractures.[10] Further, low socioeconomic groups consume low calcium rich foods with low protein, calories and micronutrients,[11] resulting in low body mass indexs (BMIs) and increasing the risk factors for early fractures.

Review of the literature suggests that there is not much data available on the bone parameters of osteoporotic hip fractures in low socioeconomic groups of India. Therefore, a hospital-based case-control study was carried out to measure the prevalence of osteoporosis and its risk factors in men and women with clinically confirmed osteoporotic hip fractures with similar age and sex matched controls of low socioeconomic group.

MATERIALS AND METHODS

A hospital-based case-control study was carried out in Osmania General Hospital (OGH), a tertiary referral hospital attached to Osmania medical college, Hyderabad, Andhra Pradesh, India. It provides services to half million population of the surrounding areas, and most of the patients belong to low socioeconomic groups. At 5% Significance level, with 80% power and standard deviation of hip BMD of 0.15 g/cm² and expected difference of 0.07g/cm², the required sample size was 72 per each gender. Accordingly, a total of 144 cases (72 men and 72 women) in the age group of 35-70 years belonging to low-income group (LIG) with history of fresh trivial injury, clinically confirmed osteoporotic hip fractures admitted in the Orthopedics ward of the OGH, from the period of April 2005-March 2008, were recruited for the study. Age and gender matched subjects (men: 72 and women: 46) from low-socioeconomic households (LIG) residing in Hyderabad, were recruited as controls.

The cases and controls were transported to National Institute of Nutrition for investigations such as Dual-energy X-ray absorptiometry (DEXA), biochemical parameters, anthropometry and clinical examination. Background information of the subjects like family history of fracture, and social status was obtained. Subjects with medical conditions like epilepsy, asthma, cardiovascular accident, high blood pressure, diabetes, hyper-and hypo-thyroidism and malabsorption syndrome, consumption of medicines for tuberculosis, on steroids, and conditions like history of delayed menarche, delayed puberty in males, polio or obvious physical disabilities, chronic immobilization problems, joint problems like rheumatoid arthritis, use of radioisotope for clinical investigation in the last month were excluded from the study as these conditions might influence bone metabolism.

Subject's weight and height were recorded on DEXA table owing to the nonambulatory movement of the subjects. The height of the subjects in lying down position and weight from DEXA readings were standardized with normal individuals. The height of the subjects with fractures was recorded in lying down position nearest to 0.1 cm by using stadiometer (SECA, Birmingham, UK) and weights of all cases were taken from DEXA recordings. The height of all the control subjects was measured nearest to 0.1 cm by making the subjects to stand erect without shoes using stadiometer (SECA, Birmingham, UK). The weights of all controls were recorded nearest to 0.1 kg using lever actuated SECA balance. The body composition data such as body fat, lean mass and body fat percentage were taken from DEXA readings. The World Health Organization recommended BMI cut-off values for Asian adults were used.[12]

A fasting blood sample was drawn in the morning and all the biochemical investigations viz., serum calcium, 25-hydroxy Vitamin D was estimated using radioimmunoassay (Dia sorn Inc., Still water, Minnesota, USA), parathorormone (PTH) by using immunoradiometric assay (Dia sorn Inc., Still water, Minnesota, USA), alkaline phospahatase total, alkaline phospahatase bone-specific, acid phosphatase total, and urinary calcium by atomic absorption spectroscopy was carried out in sub-sample.

Measurement of BMD is a gold standard for diagnosis of osteoporosis as per the International agreed definition of osteoporosis.[13] DEXA provides an objective and quantifiable index of skeletal strength that is widely used in clinical practice.[14] The BMD of the subjects was determined by the DEXA (DEXA, QDR 4500W; Waltham, MA, USA). In the fractured cases, BMD was obtained from the nonfractured side before any treatment. BMD of the hip, femoral neck, trochanter, wards triangle, inter trochanter, total hip, spine, whole body, and body composition were obtained from DEXA scans were taken according to the instrument manual. The quality control of the machine was done daily with standard calibration and as per the quality control protocol.

The study was approved by the Scientific Advisory Committee Indian Council of Medical Research, New Delhi, and ethical clearance was obtained from Institutional ethical review board and the Hospital Ethical Committee.

Statistical analysis

SPSS window version 19.0 (National Institute of Nutrition, Indian Council of Medical Research, Jamai-Osmania (P.O), Hyderbad, India) was used for data analyses. Mean and standard deviations were calculated for comparison of demographic, bone and biochemical variables among groups by "*t*"-test and distribution of T-scores of osteoporosis among groups by Chi-square test. Multiple regression analysis was carried out to study the relationship of BMD as a dependent variable with body composition, group of subjects and biochemical as independent variable. Level of significance was considered at *P* value below 0.05.

RESULTS

The cases and control were equally distributed between men and women, and there was no difference between the mean age of the fractured subjects and normal controls [Table 1]. The fractures occurred at the mean age of 59.1(95% confidence interval [CI] 56.9-61.2) in men and 63.6 (95% CI 61.3-65.9) in women. The mean height of the cases was significantly ($P < 0.001$) more than the control subjects in women. The important nutritional status indicator BMI was significantly ($P < 0.001$) lower in fractured subjects than the controls in both genders. The total fat mass was significantly ($P < 0.05$) lower in women with fractures than the women in the control group. The subjects with fractures had significantly lower total lean body mass than those of the control group ($P < 0.01$). Bone mineral densities at femoral neck, trochanteric, inter trochanteric,

hip area and wards triangle was significantly lower both for men and women with fractures than the control subjects [Table 2]. Bone mineral content was significantly ($P < 0.05$) lower in the fracture subjects at whole body in both gender, but lower levels of bone mineral content were found in cases with fractures at all sites in both men and women. There was not much difference in all bone areas except in trochanteric area where the bone area was significantly ($P < 0.05$) lower in women with fractures.

Prevalence of osteoporosis

Among the cases, at hip region 18.1% of men had osteoporosis, and 51.4% of men had osteopenia [Table 3]. In the case of women with fractures, 37.8% had osteoporosis, and 45.9% had osteopenia. BMD at the hip region was significantly ($P < 0.001$) lower among the cases compared controls in both men and women. However, in the control population the prevalence of osteoporosis and osteopenia among the men was 1.4% and 43.8%, respectively, while the corresponding figures for women were 8.5%, and 48.9%, respectively. Similarly, among the cases at trochanteric region, the prevalence of osteoporosis and osteopenia among men was 25% and 56.9%, respectively. In the case of women, the corresponding figures were 71.6% and 27.0% respectively, and BMD was significantly ($P < 0.001$) lower in cases as compared to controls in both men and women. However, in the control population 4.1% of men and 38.3% of women had osteoporosis, while the prevalence of osteopenia among men and women was 60.3% and 48.9%, respectively.

Table 1: Mean (±SD) values of physical, anthropometric and body composition of cases and of the controls by gender

Variable	Cases	Controls	P^1
	Mean ± SD	Mean ± SD	
Gender			
Men	72	72	
Women	72	46	
Age (mean)			
Men	59.1±9.42	57.5±10.82	0.348
Women	63.6±9.97	62.30±8.77	0.462
Height (cm)			
Men	164.3±6.03	160.3±6.82	<0.001
Women	151.78±6.05	147.69±5.68	<0.001
Weight (kg)			
Men	48.5±1.29	53.8±10.66	0.004
Women	44.62±9.68	49.99±12.20	0.008
BMI (Kg/m²)			
Men	17.9±3.66	20.9±3.75	<0.001
Women	19.3±3.87	22.7±4.70	<0.001
Total fat mass (g)			
Men	10082.4±5403.08	11276.0±5351.05	0.181
Women	14862.5±6086.98	17349.6±6999.90	0.042
Total lean body mass (g)			
Men	36086.8±7588.15	39281.2±5999.85	0.005
Women	28219.8±4085.57	306343.0±5252.31	0.006
Total percentage of body fat mass			
Men	19.9±5.97	20.5±6.27	0.598
Women	32.3±7.98	33.8±6.81	0.297

[1]*t*-test was used to see significant differences between both the groups, SD = Standard deviation

At inter trochanteric region among males with fractures, 33.3% were osteoporotic, and 47.2% were osteopenic. BMD of the cases was significantly ($P < 0.001$) lower than the controls. In the women with fractures, 60.8% were osteoporotic, and 31.9% were osteopenic and BMD was significantly ($P < 0.01$) lower than the controls. However, in the control population of men and women 1.4% and 31.9% had osteoporosis and 52.1%and 53.2% were osteopenia. Among the cases at femoral neck region in men, 37.0% had osteoporosis, and 43.8% had osteopenia. BMD of the cases was significantly ($P < 0.05$) lower than the controls. In the women with fractures, 59.5% were osteoporotic, and 31.1% were osteopenia. BMD was also lower among cases which were not significant, and only a trend was observed. However, in the control population of men and women 17.8% and 38.3% had osteoporosis and 61.6%, and 42.6% had osteopenia. Similarly, 56.9% of men with fractures were osteoporotic, and 33% had osteopenia at wards triangle region. In the women with fractures, 85.1% were osteoporotic, and 14.9% are osteopenia. Similar to hip and trochanteric regions, at ward triangle also BMD was significantly ($P < 0.001$) lower than the controls in both men and women. However, in the control population of men and women 19.2% and 57.2% had osteoporosis and 61.6%, and 34% had osteopenia. At spine region, 59.5% men among the cases had osteoporosis and 24.3% were having osteopenia, and only weak associations with controls were noted. In the women cases, 85% had an osteoporosis, 9.5% are osteopenia, and weak association with controls was observed. However, in normal control subject's 41.4% men and 78.7% of women had osteoporosis and 38.4%, and 14.9 were osteopenia.

Profile of biochemical variables

There were significantly lower levels of calcium ($P < 0.05$) and Vitamin D ($P < 0.001$) in the subjects with fractures than the controls [Table 4]. There was high paratharmone activity in the subjects with fractures as compared to the controls. The serum levels of total alkaline phosphatase were significantly ($P < 0.05$) lower in women with fractures than the controls. There was a significantly ($P < 0.001$) high excretion of urinary calcium in fractured men and women as compared to the controls. Step-wise regression models were developed with BMD values at hip, femoral neck, trochanteric, spine, wards triangle and whole body BMD as dependent variables and gender, height, BMI, height, PTH, 25-hydroxy Vitamin D, alkaline phosphtase total and serum calcium as independent variables. Gender, BMI, serum Vitamin D, were explaining the variation in BMD at all the sites, whereas height was also positively associated with BMDs at hip, neck of femur, trochanter and whole body as shown in Table 5.

DISCUSSION

This is the first hospital-based case-control study to assess the bone parameters in human subjects who had osteoporotic hip fractures

Table 2: Mean (±SD) bone parameters of both cases and controls by gender

Variables	Men		*P*	Women		*P*[1]
	Cases (72)	Controls (72)		Cases (72)	Controls (46)	
Femoral neck						
Area (cm²)	5.21±0.824	5.18±0.416	0.720	4.26±0.932	4.46±0.27	0.143
BMC (g)	3.52±0.99	3.74±0.63	0.116	2.68±0.92	2.73±0.53	0.746
BMD (g/cm²)	0.622±0.12	0.72±0.114	<0.001	0.511±0.11	0.61±0.13	<0.001
Trochentric						
Area (cm²)	11.08±2.12	11.43±1.37	0.234	8.31±2.51	9.46±1.25	0.004
BMC (g)	6.84±2.34	7.10±1.28	0.407	4.52±2.10	4.63±1.26	0.754
BMD (g/cm²)	0.55±0.12	0.63±0.11	<0.001	0.40±0.099	0.49±0.11	<0.001
Inter trochentric						
Area (cm²)	21.52±3.39	20.16±2.14	0.05	16.13±3.58	15.79±1.63	0.539
BMC (g)	19.23±4.77	20.50±3.50	0.68	12.37±3.47	12.60±3.05	0.713
BMD (g/cm²)	0.85±0.16	1.01±0.138	<0.001	0.66±0.15	0.79±0.17	<0.001
Hip area						
Bone area (cm²)	37.81±5.26	36.80±3.37	0.171	28.69±6.43	29.77±2.49	0.275
BMC (g)	29.64±7.25	31.34±5.04	0.102	28.69±6.43	29.77±2.49	0.275
BMD (g/cm²)	0.73±0.14	0.85±0.12	<0.001	0.56±0.12	0.67±0.14	<0.001
Whole body						
Bone area (cm²)	1704.75±211.53	1776.47±180.50	0.029	1377.98±185.71	1434.52±183.39	0.106
BMC (g)	1792.22±360.78	1910.48±308.67	0.035	1198.53±269.36	1325.09±287.28	0.016
BMD (g/cm²)	1.04±0.11	1.07±0.089	0.109	0.862±0.10	0.897±0.09	0.060
Wards triangle						
Bone area (cm²)	1.09± 0.19	1.14±0.04	0.044	1.04±0.28	1.14±0.27	0.015
BMC (g)	0.59±0.24	0.61±0.15	0.416	0.52±0.28	0.49±0.16	0.490
BMD (g/cm²)	0.46±0.15	0.54±0.14	0.002	0.36±0.09	0.43±0.14	<0.001

[1]*t*-test was used to see significant differences between both the groups, SD = Standard deviation, BMD = Bone mineral density, BMC = Bone mineral content

Table 3: Prevalence (%) of osteoporosis and osteopenia according to BMD T-scores by gender

Variables	Men		*P*	Women		*P*[1]
	Cases (72)	Controls (72)		Cases (72)	Controls (46)	
Hip						
≤2.5	18.1	1.4	<0.001	37.8	8.5	<0.001
−2.5-1	51.4	43.8		45.9	48.9	
>1	30.6	54.8		16.2	42.6	
Trochentric						
≤2.5	25	4.1	0.001	71.6	38.3	<0.001
−2.5-1	56.9	60.3		27.0	48.9	
>1	18.1	35.6		1.4	12.8	
Inter trochentric						
≤2.5	33.3	1.4	<0.001	60.8	31.9	0.002
−2.5-1	47.2	52.1		36.5	53.2	
>1	19.4	46.6		2.7	14.9	
Femoral neck						
≤2.5	37	17.8	0.028	59.5	38.3	0.060
−2.5-1	43.8	61.6		31.1	42.6	
>1	19.2	20.5		9.5	19.1	
Wards triangle						
≤2.5	56.9	19.2	<0.001	85.1	57.4	0.001
−2.5-1	33	61.6		14.9	34.0	
1	9.7	19.2		0	8.5	
Spine						
≤2.5	59.5	41.4	0.076	85.1	78.7	0.630
−2.5-1	24.3	38.4		9.5	14.9	
>1	16.2	20.5		5.4	6.4	

[1]Chi-square test was used to see significant differences between both the groups, BMD = Bone mineral density

Table 4: Distribution (%) by biochemical parameters of cases and controls according to gender

Variables	Men		*P*	Women		*P*[1]
	Cases	Controls		Cases	Controls	
Serum calcium (mg/dl)						
<8.5	37.8 (28)	23.1 (9)	0.001	37.8 (28)	20.0 (4)	0.016
8.6-10.2	37.8 (28)	71.8 (28)		50 (37)	80.0 (16)	
>10.2	24.3 (18)	5.1 (2)		12.2 (9)	0 (0)	
25-hydroxy vitamin D (ng/ml)						
<20	72.2 (52)	8.7 (2)	<.001	76.1 (54)	0 (0)	<.001
>20	27.8 (20)	91.3 (21)		23.9 (17)	100 (12)	
PTH (Pg/ml)						
<9	4.0 (2)	3.0 (1)	0.968	4.693)	0 (0)	0.163
9-55	70.0 (35)	69.7 (23)		50.8 (33)	72.7 (13)	
>55	26.0 (13)	27.3 (9)		44.6 (29)	27.8 (5)	
Alkaline phosphates, total (IU/L)						
20-80	69.0 (50)	58.5 (74)	0.364	70.3 (52)	42.9 (9)	0.021
>80	31.1 (17)	41.5 (40)		29.7 (22)	57.1 (12)	
Acid phosphates, total (IU/L)						
0.5-9.3	37.0 (28)	14.7 (5)	0.012	37.8 (28)	26.7 (4)	0.305
>9.3	62.2 (46)	85.3 (29)		62.2 (46)	73.3 (11)	
Alkaline phospahatase, bone-specific (IU/L)						
<6	5.4 (4)	11.8 (4)	0.197	1.4 (1)	0 (0)	0.690
6-20	21.6 (16)	32.4 (11)		27.0 (20)	20.0 (3)	
>20	73.0 (54)	55.9 (19)		71.6 (53)	80.0 (12)	
TRAP (IU/L)						
2.2-3.8	2.8 (2)	0 (0)	0.465	2.7 (2)	0 (0)	0.690
>3.8	97.3 (72)	100 (34)		97.3972)	15 (100	
Urinary calcium(mg/dl)						
<5	39.7 (27)	65.5 (19)	0.017	31.9 (23)	84.6 (11)	0.001
5-40	60.3 (47)	34.5 (10)		68.1 (49)	15.4 (2)	

[1]Chi-square test was used to see significant differences between both the groups, PTH = Parathorormone, TRAP

Table 5: Stepwise Regression models for BMD at different sites with body composition and biochemical parameters

Dependent variable	Ordinary variable	R^2 (%)	*P*
Hip	Sex, BMI, 25-Hydroxy Vitamin D and height	56.5	<0.001
Neck	25-hydroxy Vitamin D, height, BMI, sex	50.5	<0.001
Trochentric	Sex, 25-hydroxy Vitamin D, BMI, alkaline phosphatase total, height, PTH	54.7	<0.001
Spine	Sex, BMI, alkaline phosphatase total, 25-hydroxy Vitamin D	41.8	<0.001
Whole body	Sex, BMI, 25-hydroxy Vitamin D and height	53.4	<0.001
Wards triangle	Sex, BMI, alkaline phosphatase total, calcium and 25-hydroxy Vitamin D	40.9	<0.001

BMI = Body mass index, BMD = Bone mineral density

among low socioeconomic groups in India. Reports on influence of socioeconomic status as a risk factor for osteoporosis and fractures are scanty, but this study indicates these sections were more at risk for osteoporosis as well as fractures. Hip fractures among western populations, are mostly reported among at 75-84 years age.[15] A positive association with the increased age and the occurrence of osteoporosis fractures was expected,[1] but this study shows that fractures occur more than 10 years earlier than the western population, at the mean age of 59.1 years (95% CI 56.87-61.24) in men and 63.6 years (95% CI 61.30-65.92) in women. The high prevalence of Osteopenia combined with high fracture rates in Indians at an early age compared to developed countries should alert public health professionals and need for tackling the disease at an early stage.

Body weight and height has a positive influence on BMD through its load bearing effects on the bone that strengthens it. Several Studies in developed countries have shown that height, BMI and fat-free mass (lean mass) are all positively associated with bone mass density at hip, spine and forearm after adjusting for important confounding factors.[16,17] This Study confirms similar relationship in low socioeconomic groups in India. fat mass was not related to bone mass density in our study, and this is in conformity with the other studies where body fat was not considered to be protective or has any association with fracture outcome.[18] This attains great importance as the high prevalence of chronic energy deficiency, stunting and lower lean mass in Indians[11,12] could be one of the reasons for the

high prevalence of Osteoporosis and its associated fractures at a very young age in India. Gender, BMI, height, along with serum Vitamin D explained variation in BMD at most of the sites [Table 5].

In our study, chronic smoking had a higher risk of developing osteoporotic fractures (odds ratio [OR] 1.19 95% CI 0.62-2.3), regular alcohol consumption had lower odds (OR 0.64 95% CI 0.3-1.37) of developing fracture. However, there was no significant association with smoking and alcohol in developing osteoporotic fractures. Smoking and alcohol are known to be inversely related to BMD and Increased fracture risk. Among women, menopause (0.65 95% CI 0.29-1.5) also had no significant impact in developing risk of fractures in our study. The nonsignificant associations may be attributed to smaller sample size compared to the large scale cross-sectional studies seen in the developed world.

Leslie *et al.*[19] showed a high prevalence of osteoporotic fractures at smaller hip bone areas. However, our study showed that there was no association with bone area and occurrence of fractures. In addition, fracture cases had slightly better bone area than the controls, at trochanteric in women and intertrochanteric in men. Similarly, no association was observed between bone mineral content and occurrence of fractures, but at all sites the bone mineral content was low. Relatively higher bone areas with low BMC led to decreased BMDs, as seen by low bone densities at trochanter, intertrochanteric, femoral neck, hip, and spine, wards triangle in both cases and controls in this study.

Studies from India have shown that there is a strong correlation with poor bone health, lower BMDs and high prevalence of 25-hydroxyl Vitamin D deficiency in low socioeconomic populations.[20] Our study also demonstrated that low serum calcium levels, and 25-hydroxyl Vitamin D in both genders are associated with lower BMDs and fractures. Further regression analysis indicated that 25-hydroxyl Vitamin D was positively associated at hip, femoral neck, trochanteric, intertrochanteric, spine whole body and wards triangle BMD similar to other studies.[21,4] A recent Meta-analysis has shown that calcium with 25-hydroxy Vitamin D deficiency is associated with a reduction of bone mass at hip and spine.[22] Studies from India done on the low socioeconomic groups show that dietary calcium intake was only 300 mg/dL, which is 700 mg less than the required amount.[20] Inadequate level of 25-hydroxyl Vitamin D (25 [OH] D) and calcium seen in our study may also be responsible for low BMD[23] and fractures in this population. Even though there was no significant association with bone densities and increased levels of PTH, it still could be the triggering factor for the occurrence of fracture as reported by other studies.[24] Our study also showed significantly high excretion of calcium in the urine in cases compared to controls, possibly because of immobilization of cases during the hospital stay.

LIMITATIONS OF THE STUDY

The study defined low socioeconomic group based on the type of hospital (Government Hospital) used by the people and was not based on national or international guidelines. Lack of cases and control subjects from middle and high socioeconomic groups was also a limitation as recruitment of these subjects would have provided wider inference to the population. Finally, dietary intakes of the subjects were not taken as the study was hospital based, and collection of such data may not reflect the true dietary intakes of the subjects.

CONCLUSION

Thus, the study reports a high prevalence of osteoporosis and osteopenia at all skeletal sites in both cases and controls in low socioeconomic sections. This study of bone parameters and risk factors among fractured patients is the first of its kind in India. The high prevalence of Osteopenia combined with high fracture rates in Indians at an early age compared to developed countries is a wakeup call to the public health professionals. There is a need for osteoporosis prevention programs such as dietary modification, increased exposure to sunlight and physical activity through education, supplementation of Vitamin D and calcium from early age, behavior modification, self-care management, health care awareness programs to the health professional, which have shown prevent the future onset of osteoporotic fractures.

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