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Prevalence and Associated Risk Factors of Osteoporosis in Post-Menopausal Women in North India

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ABSTRACT

Introduction: Osteoporosis is a global health problem contributing to increased functional limitations (mortality, morbidity, disability) and economic costs. The study aimed at assessing the prevalence and risk factors of osteoporosis in a sample of post-menopausal women from the states of Punjab, Haryana and Chandigarh in North India. **Methods:** A total of 250 post-menopausal women, ranging in age from 45 to 80 years, were selected by purposive sampling from three states in North India. Information was collected on height, weight, waist and hip circumferences, grip strength, dietary intake, physical activity, and exposure to sunlight. Bone mineral density (BMD) was evaluated by using Dual Energy X-ray Absorptiometry (DXA) at lumbar spine (L1-L4). **Results:** The prevalence of osteoporosis at lumbar spine (L1-L4) was found in 26.4% of the post-menopausal women. Osteoporotic women were significantly shorter (155.17 vs. 157.57, $p<0.05$) and lighter (55.5 vs. 63.96, $p<0.05$) than non-osteoporotic women. Non-osteoporotic subjects exhibited significantly higher mean values for waist circumference (83.78 vs. 79.51, $p<0.05$) as well as hip circumference (93.05 vs. 86.83, $p<0.05$) as compared to osteoporotic subjects. Grip strength of both dominant and non-dominant hand was significantly higher in non-osteoporotic women than their osteoporotic counterparts. Bone mineral density was highest in women with body weight between 51-60 kg and BMI between 18.5-24.9 kg/m^2. Binary logistic regression analysis identified weight (OR=1.13; CI 1.05-1.21) as possible predictors of osteoporosis. **Conclusion:** A positive trend was observed between bone mineral density and non-vegetarian diet as well as moderate physical activity in both osteoporotic and non-osteoporotic subjects.

Key words: Bone mineral density, osteoporosis, post-menopausal women, vegetarian diet

INTRODUCTION

Osteoporosis is characterised by low bone mass with micro-architectural deterioration of bone tissues resulting in a reduction in bone strength and increased susceptibility to fracture (CDC, 1993; Prentice,1997). Normal ageing is the primary cause of osteoporosis, but it can also arise as a result of impaired development of peak bone mass associated with delayed puberty or undernutrition or excessive bone loss during adulthood as well as due to a decline in estrogen level in women, or corticosteriod use (WHO, 2003).

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Osteoporosis is further influenced by certain modifiable (sedentary life style, unbalanced diet, excessive alcohol intake) and non-modifiable (sex, ageing, and family history of fracture) risk factors. Osteoporosis is not only the main cause of fractures, it is also one of the major reason responsible for a bedridden status with serious health implications. These complications may be life threatening in elderly people along with their functional limitations. The number of osteoporotic fractures is expected to increase in both men and women (by more than three-fold over the next 50 years) as a result of the ageing population.

Furthermore, there is a major increase in the proportion of worldwide osteoporotic burden but it is particularly higher in Asia and Latin America. Because of the morbid consequences of osteoporosis, the prevention of this disease along with its associated fractures is of utmost importance for the maintenance of health, quality of life, and independence in the elderly population (WHO, 2004).

Therefore evaluation of different risk factors is an important step for the control of osteoporosis. Hence, the present research is an attempt to assess prevalence and risk factors of osteoporosis among post-menopausal women of North India.

METHODS

The study was conducted in the states of Punjab, Haryana and Chandigarh Union territory in north India. The people of this region belong to the Indo-Aryan type. Subjects of this study were of Hindu and Sikh religions.

The present cross-sectional study comprised of two hundred and fifty post-menopausal women, between 45 to 80 years of age, selected by purposive sampling method. Data collection was carried out from March 2011 to September 2011 from the three states of north India. Background information of all the subjects in relation to their age, education, occupation, number of children, number of abortions and menopausal status was collected using a detailed questionnaire. Women who were Rh positive, free from chronic diseases affecting bone and not taking bone-altering medications/ estrogen replacement therapy were included in the study.

Questions related to consumption/ frequency of different food items (vegetarian/ non vegetarian diet) as well as awareness about the meaning and effects of osteoporosis were also asked. Level of daily physical activity and exposure to sunlight of the post-menopausal women was gauged using a questionnaire. On the basis of this questionnaire, physical activity of the participants was stratified into three categories; no activity, mild activity (0-20 minutes/ day), moderate (21-40 minutes/ day). All the subjects were grouped into two categories on the basis of their exposure to sunlight: Yes (at least 15-30 minutes exposure per day), No (>15 minutes or no exposure per day).

Informed consent from each subject and ethical committee clearance was obtained from the Institute (Kurukshetra University, Kurukshetra).

The four anthropometric measurements taken on all the subjects include height (cm), weight (kg), waist circumference (cm) as well as hip circumference (cm). Height (cm) and weight (kg) were measured by anthropometer and weighing machine respectively. Waist circumference (cm) and hip circumferences (cm) of each subject were measured with Freeman's steel tape. Waist circumference (cm) was measured at the minimum circumference between the iliac crest and the rib cage. Hip circumference (cm) was measured at the maximum protuberance of the buttocks. Body mass index (BMI) was calculated as body weight divided by height squared (kg/m2).

Bone mineral density was assessed using Dual Energy X-ray Absorptiometry (DXA) at lumbar spine (L1-L4) (GE

Healthcare Lunar enCORE, Madison, USA). Classification based on T-scores (WHO,1994) was followed to define osteoporosis; T scores <-2.5 SD was used as the cut- off value in the diagnosis of osteoporosis, T scores between -2.5 SD and -1 SD was for low bone mass (osteopenia), and T scores >-1 SD was considered as normal.

All the non osteoporotic (normal and osteopenic subjects) and osteoporotic subjects (WHO, 1994) were classified into their normal, underweight and overweight categories depending upon the WHO (1995) criteria of body mass index. Hand grip strength (kg) was measured using Dynamometer (Analogue model, range 0-100kg, made in Japan). Subjects were encouraged to exert their maximal grip. The subjects performed three hand grip tests with each hand. The best result was chosen for analysis.

Statistical analysis

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 14.0. Mann Whitney U test was employed to find out statistical significance of the differences between groups. Binary logistic regression analysis was performed to identify possible predictors of osteoporosis.

RESULTS

Table 1 presents general characteristics of the subjects. Overall prevalence of osteoporosis was found to be 26.4% at lumbar spine (L1-L4) among post-menopausal women. Most of the osteoporotic women (83.33%) (T scores <-2.5 SD) as well as non-osteoporotic women (80.97%) (T scores >-2.5 SD) of present study were vegetarian. Both the osteoporotic and

Table 1. General characteristics of the sample

Variables	*Non-osteoporotic*	*Osteoporotic*	*Total*
Prevalence N (%)	184 (73.6%)	66 (26.4%)	250 (100%)
Diet			
Vegetarian N (%)	149 (80.97%)	55 (83.33%)	204 (81.6%)
BMD (g/cm^2) Mean± S.D	0.912± 0.14	0.766±0.06	
Non-vegetarian N (%)	35 (19.02%)	11 (16.66%)	46 (18.4%)
BMD (g/cm^2) Mean± S.D	0.925± 0.16	0.769±0.08	
Physical activity			
No N (%)	102 (55.43%)	31 (46.96%)	133 (53.2 %)
BMD (g/cm^2) Mean± S.D	0.896±0.10	0.761 ±0.07	
Mild (0-20 minutes/day) N (%)	53 (28.8%)	25 (37.87%)	78 (31.2%)
BMD (g/cm^2) Mean± S.D	0.912±0.15	0.763± 0.06	
Moderate (21- 40minutes/day) N (%)	29 (15.76%)	10 (15.15%)	39 (15.6%)
BMD (g/cm^2) Mean± S.D	0.943±0.15	0.771± 0.05	
Exposure to sunlight			
Yes (15-30 minutes/day) N (%)	89 (48.36%)	27 (40.9%)	116 (46.4%)
BMD (g/cm^2) Mean± S.D	0.929± 0.14	0.771± 0.08	
No (0-15 minutes/day) N (%)	95 (51.63%)	39 (59.09%)	134 (53.6%)
BMD (g/cm^2) Mean± S.D	0.911± 0.15	0.760±0.06	
Knowledge about osteoporosis			
Yes N (%)	36 (19.56%)	12 (18.18%)	48(19.2%)
No N (%)	148 (80.43%)	54 (81.81%)	202 (80.8%)

Table 2. Mean, standard deviation and odds ratio of various morpho-physiological variables of osteoporotic and non-osteoporotic post-menopausal females

Morpho-physiological variables	*Non-osteoporotic females (N=184) Mean ±S.D*	*Osteoporotic females (N=66) Mean ±S.D*	*Odds ratio (95 % CI)*
Height (cm)	157.57± 6.86	155.17± 8.71*	0.93 (0.87-1.21)
Weight (kg)	63.96± 11.04	55.50± 10.69*	1.13 (1.05-1.21)*
BMI (kg/m ²)	24.90± 4.45	25.65± 4.51	1.01 (0.93-1.11)
Waist circumference (cm)	83.78± 8.58	79.51± 8.55*	0.94 (0.87-1.03)
Hip circumference (cm)	93.05± 10.52	86.83± 9.56*	0.96 (0.89-1.03)
Dominant hand grip strength (kg)	15.96± 5.37	13.19± 4.44*	1.06 (0.84-1.34)
Non-dominant hand grip strength (kg)	13.73 ±4.92	11.42± 4.05*	0.92 (0.72-1.18)

* Mann-Whitney U test statistically significant ($p<0.05$)

non-osteoporotic subjects who had a non-vegetarian diet demonstrated higher bone mineral density (BMD) as compared to their vegetarian counterparts. About 55.43% of non-osteoporotic women had a sedentary lifestyle, while of the remaining 28.8%, 15.76% demonstrated mild and moderate physical activity respectively. Among osteoporotic women, 46.96% had no physical activity, and 37.87% and 15.15% females exhibited mild and moderate activity, respectively. Women with moderate physical activity revealed higher bone mineral density (osteoporotic = 0.771 + 0.05g/cm², non-osteoporotic = 0.943 +0 .15 g/cm²) as compared to their counterparts showing mild (BMD: osteoporotic = 0.763+0.06 g/cm², non-osteoporotic = 0.912 +0.15 g/cm²) or no physical activity (BMD: osteoporotic = 0.761+0.07 g/cm², non-osteoporotic = 0.896 +0.10 g/cm²). About 48% of non-osteoporotic (BMD = 0.929 +0.14 g/ cm²) and 41% of osteoporotic (BMD= 0.771+ 0.08 g/cm²) women had direct exposure to sunlight (15-30 minutes/day). Most of the women of the present study (80.8%) had no knowledge on the meaning and effects of osteoporosis.

Comparisons of various morpho-physiological variables (height, weight, waist circumference, hip circumference, dominant and non-dominant hand grip strength) between 184 non-osteoporotic and 66 osteoporotic post-menopausal women are shown in Table 2. It is evident from the table that osteoporotic women were significantly shorter (155.17 vs 157.57, $p<0.05$) and lighter (55.50 vs. 63.96, $p<0.05$) than non-osteoporotic women. Non-osteoporotic women exhibited higher mean values for waist circumference (83.78 vs. 79.51, $p<0.05$) as well as hip circumference (93.05 vs. 86.83, $p<0.05$) as compared to osteoporotic women and differences were statistically significant. Grip strength for both dominant (15.96 vs 13.19, $p<0.05$) and non-dominant hand (13.73 vs. 11.42, $p<0.05$) of non osteoporotic women was significantly greater than osteoporotic women. Binary logistic regression analysis (Table 2) demonstrated that odds of having osteoporosis was 0.93 (0.87-1.21) for height, 1.01 (0.93-1.11) for body mass index and 1.06 (0.84-1.34) for dominant hand grip strength. The strongest predictor of osteoporosis was weight (OR=1.13; CI 1.05-1.21).

All the osteoporotic (T-scores <-2.5 SD) and non-osteoporotic (T-scores > -2.5 SD) women were stratified into four groups (<40 kg, 41-50 kg, 51-60 kg, >60kg) on the basis of

Table 3. Mean and standard deviation of bone mineral density of different categories of body weight and body mass index of osteoporotic and non-osteoporotic post-menopausal females

Parameters	*Non-osteoporotic females Bone mineral density Mean ±S.D*	*Osteoporotic females Bone mineral density Mean ±S.D*
Weight (kg)		
<40 kg	0.836 + 0.11	0.695 + 0.10
41-50 kg	0.895 + 0.13	0.759 + 0.05
51-60 kg	0.969 + 0.14	0.792 + 0.06
>60kg	0.930 + 0.15	0.764 + 0.06
Body Mass Index (kg/m $^{2)}$		
<18.5 kg/m^2	0.917 ± 0.13	0.776 ± 0.03
18.5 -24.9 kg/m^2	0.951 ±0.17	0.848 ± 0.05
>/=25 kg/m^2	0.899 ±0.12	0.760 ± 0.07

their body weight and three groups (<18.5 kg/m^2, 18.5 -24.9 kg/m^2, >/=25 kg/m^2) on the basis of their body mass index (Table 3). It is evident from this table that bone mineral density is maximum in the women with body weight between 51-60 kg and body mass index between 18.5 -24.9 kg/m^2. In both the non osteoporotic and osteoporotic groups, underweight women (BMD: 0.917+ 0.13 g/cm^2 vs 0.776+0.03 g/cm^2) and women in the overweight/ obese category (0.899 +0.12 g/cm^2 vs 0.760+0.07 g/cm^2) had lower bone mineral density respectively, thereby contributing to increased fracture risk.

DISCUSSION

Osteoporosis diagnosed by low bone mineral density is a "silent" disease, because bone loss occurs without any symptoms. In the present study, overall prevalence of osteoporosis at lumbar spine (L1-L4) was 26.4% among post-menopausal women. In most Western countries, the peak incidence of osteoporosis occurs at about 70-80 years of age but in India, it may afflict an age group that is 10-20 years younger, at age 50-60 (Damodaran *et al.*, 2000). A significantly higher proportion of osteoporotic (83.33%) as well as non-osteoporotic (80.97%) women of the present study was vegetarian. Bone mineral density, the main determinant of fracture risk was higher in subjects who consumed a non-vegetarian diet as compared to their vegetarian counterparts in both the osteoporotic (0.769 g/cm^2 vs 0.766 g/cm^2) and non-osteoporotic (0.925 g/cm^2 vs 0.912 g/cm^2) women. Keramat *et al.* (2008) noticed that pure vegetarianism has been a risk factor of osteoporosis in India. Hannan *et al.* (2000) reported greatest bone loss over 4 years in those with the lowest animal and total protein intake. A low protein intake in the elderly may contribute to the risk of osteoporotic fracture.

Osteoporotic women (40.9%) had less exposure to sunlight (0-15 minutes/day), which is a natural source of vitamin D than non-osteoporotic (48.36%) subjects of the present study. Women who had greater exposure to sunlight (15-30 minutes/day) showed higher bone mineral density as compared to their counterparts with less exposure to sunlight (0-15 minutes/day) in both the osteoporotic (0.771 g/cm^2 vs 0.760 g/cm^2) and non- osteoporotic (0.929 g/cm^2 vs 0.911 g/cm^2) women. Comparative analysis in terms of level of daily physical activity observed a positive trend between bone mineral density and subjects having a moderate level of physical activity. Findings of Khan *et al.* (2000) show that physical

activity has beneficial effects on the skeleton by contributing significantly to attainment of peak bone mass. The present study corroborates previous cross-sectional studies (Bailey *et al.*, 1999; Kolahi *et al.*, 2011) that documented a significant relationship between more physical activity and higher bone mineral density (BMD). Most of the females of the present study (80.8%) had no knowledge of the meaning and effects of osteoporosis. This may be attributed to illiteracy, restricted mobility and social isolation coupled with less health care services available to the elderly female.

In the current cross-sectional study, osteoporotic women were significantly shorter (OR=0.93; CI 0.87-1.21) and lighter (OR=1.13; CI 1.05-1.21) than non-osteoporotic subjects. Bone mineral density was maximum in the women with body weight between 51-60kg in both the osteoporotic (0.792 g/cm^2) and non osteoporotic (0.969 g/cm^2) women. Binary logistic regression analysis identified weight (OR=1.13) as a possible predictor of osteoporosis. These findings are in close agreement with the report of Morin, Tsang & Leslie (2009) who also recognised the negative impact of low body weight on bone health. Body weight is positively associated with bone mineral density from childhood through adulthood (with correlations to the order of 0.3 to 0.6) (Reid, 2002). In the present study, women with normal body mass index (18.5 -24.9 kg/m^2) had increased bone mineral density (0.951+0.17 g/cm^2 vs 0.848 +0.03 g/cm^2) as compared to underweight (BMD= 0.917+0.13 g/cm^2 vs 0.776+0.05 g/cm^2) and overweight/ obese (0.899 +0.12 g/cm^2 vs 0.760+0.07 g/cm^2) women in both non-osteoporotic and osteoporotic subjects respectively, thereby indicating that underweight and overweight status have a negative effect on bone mineral density. It is also well illustrated by Siiteri (1987) that obese post-menopausal women tend to have high estrogenecity because androstenedione and testosterone in fat tissue are converted to estrone and estradiole, leading to high bone mineral density (BMD) and low bone turnover, which can contribute to a decreased fracture risk. In divergence with this, Manolagas (2010) reported that obesity leads to generation of reactive oxygen species (ROS) through a chronic inflammatory process, which is responsible for the deterioration of the proliferation and survival of osteoclasts, osteoblasts, and osteocytes. In convergence with these findings, Zhao *et al.* (2008) postulated that excessive fat mass may have adverse effects on bone, such as secretion of adipocyte-derived hormones and inflammatory cytokines that affect bone metabolism.

Circumferential measurements (waist OR= 0.94; 95% CI 0.87-1.03; hip OR =0.96; 95% CI 0.89-1.03) of non-osteoporotic women were better than osteoporotic women showing that the former had greater subcutaneous fat. Several previous studies (Parkkari *et al.*, 1994; Robinovitch, McMahon & Hayes, 1995; Slemenda, 1997) indicated that hip circumference may represent adiposity of the hip region and on the other hand relative lean mass in the gluteo-femoral region. Lower body mass, specifically around the hip region, may offer cushioning and consequent protection from fractures upon falling. Compared to larger hips, small hips may not offer this protection from fractures. So, non-osteoporotic women of the present study had higher weight as well as circumferences as compared to their osteoporotic counterparts.

Upper extremity muscle strength assessed by grip strength was significantly higher in non- osteoporotic women for both dominant (OR= 1.06; 95% CI 0.84-1.34) and non-dominant hand (OR=0.92; 95% CI 0.72-1.18) than osteoporotic subjects, thereby suggesting that low bone mineral density is associated with low grip strength. Dixon *et al.* (2005) also observed that low grip strength is a marker of low bone mineral density. Similar conclusions were reached by Kim, Lee & Cho (2012) showing that low

handgrip strength is associated with low bone mineral density of the spine, femur neck, and total hip, and with increased risk of previous fragility fractures. The decline in estrogen level in post-menopausal women is partly responsible for the age-associated decrement of muscle strength (Maltais *et al.*, 2009) and osteoporosis which is characterised by micro-architectural deterioration of bone tissues that further results in reduction of bone strength.

In conclusion, osteoporotic women were substantially shorter, lighter, of lesser circumference and manual strength as compared to non-osteoporotic women. Low body weight and a sedentary life style were inversely correlated with bone mineral density. Findings of the present study highlight that diet (non-vegetarian) and life style (physical activity and exposure to sunlight) of post-menopausal women are crucial factors for maintaining women's bone health. Although osteoporosis has been recognised as an alarming health problem for many years, little progress has been reported in this domain, resulting in elevated global prevalence of osteoporosis. In view of these findings, there is an urgent need to educate and generate awareness particularly among elderly females on the benefits of a balanced diet (adequate calcium and Vitamin D) along with regular physical activity to improve their bone health.

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