ORIGINAL ARTICLE

Preventable risk factors for osteoporosis in postmenopausal women: Systematic review and meta-analysis

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ABSTRACT

Background and Objective: The osteoporosis is becoming public health problem in India and neighboring Asian countries. As the environmental risk factors for osteoporosis in women are similar in these countries, the study was planned to compare risk factors for osteoporosis in postmenopausal women in Asian countries.
Materials and Methods: A systematic literature search was done in August 2015. The period included for this search was from January 2005 to December 2014. The search was done for India and neighboring countries. The final analysis was done on the studies from India, China, Korea, and Japan. The literature search was done in PubMed and Google Scholar using key words, "Osteoporosis" and "Menopause" and "Risk factor."
Results: The pooled prevalence for the osteoporosis in postmenopausal women is 41%, but in India alone, it is 53%. Various risk factors are studied in China as compared to other countries. Adequate calcium intake and various exercises were found to be useful modifiable factors. Other factors like age, height, and postmenopausal status cannot be modified.
Conclusion: Adequate calcium and Vitamin D intake and combinations of various exercises can be considered as preventive measures for osteoporosis in postmenopausal women.

Key Words: Menopause, osteoporosis, risk factor

INTRODUCTION

Osteoporosis is a slowly progressive disease and becoming public health problem in Asian countries including India. Disability due to hip or vertebral fracture is the major concern for the prevention of osteoporosis. It is expected that more than about 50% of all osteoporotic hip fractures will occur in Asia by the year 2050.[1] Most of the osteoporosis cases are underdiagnosed and undertreated, even in the most high-risk patients in Asia.[2] The problem is particularly acute in rural areas. In the most populous countries like China and India, the majority of the population lives in rural areas, where hip fractures are often treated conservatively at home.[2] Diagnosis of osteoporosis by dual-energy x-ray absorptiometry (DEXA) scan is also not possible as it is not widely available in

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the rural areas of Asian countries. In such situations, the prevention of osteoporotic fractures in high-risk groups is difficult as early diagnosis is not possible. There are nonmodifiable and preventable (modifiable) risk factors for osteoporosis. Nonmodifiable risk factors include age, height, weight, body mass index (BMI), and menopause which are not preventable. The preventable risk factors include calcium intake, exposure to sunlight, smoking, alcohol intake, exercise, underlying disease condition such as rheumatoid arthritis, systemic lupus erythematosus, and other autoimmune disorders, steroids intake, hormone replacement therapy, etc.

When the measurement of bone mineral density (BMD) by DEXA scan is not possible, osteoporosis self-assessment tool for Asians (OSTA) is used to assess the risk for osteoporosis in Asian women.[3] It consists of only two parameters age and weight. OSTA is a visual chart which gives idea about the risk of osteoporosis as low, medium, and high. Drug treatment is recommended for high-risk groups even if BMD is not measured. However, for medium and low-risk groups, BMD measurement is must to decide about the necessity of drug treatment. In nonavailability of DEXA scan, knowing other risk factors besides age and weight become important so that the treatment of osteoporosis can be initiated on time.

This systematic review and meta-analysis were carried out to study the published data on risk factors for osteoporosis in menopausal women in Asian countries such as India, China, Korea, and Japan.

MATERIALS AND METHODS

Search criteria

A systematic literature search was done in August 2015. The period included for this search was from January 2005 to December 2014. The literature search was done in PubMed and Google Scholar using key words, "Osteoporosis" and "Menopause" and "Risk factor." Published articles from India and neighboring Asian countries such as China, Korea, Japan, Hong Kong, Sri Lanka, Nepal, Singapore, and Pakistan were considered for further analysis. Abstracts were reviewed, and relevant studies with respect to the objective were sought for full paper. Duplicate studies were excluded from the analysis.

Eligibility of the studies

Studies focusing on the risk factors for osteoporosis in menopausal women were selected. Observational studies such as cross-sectional, case–control, and cohort studies were considered for further analysis. The quality of the reporting of the included studies was decided using the STRENGTHENING the Reporting of Observational Studies in Epidemiology statement.[4]

Inclusion criteria

Observational studies done in hospital and/or community were included in the study. The objective of the studies was to find out the risk of osteoporosis in pre- and post-menopausal women. Women from India and neighboring Asian countries were included in the study.

Exclusion criteria

Reviews, case reports, editorials, commentaries, letter to editor, and unpublished material were excluded from this study. Articles, in which data, is not expressed in the terms of odds ratio (OR) were excluded from the study.

Statistical analysis

Potential sources of heterogeneity between the studies were examined using the method developed by DerSimonion and Laird, which calculates between the study variation based on the statistics. We considered that there was statistically significant heterogeneity when the *P* value between the results of the included studies was below 0.05. In case with heterogeneity, we applied random-effect model as opposed to fixed-effect models because the former include both within-study sampling error (variance) and between-study variation in the assessment of the uncertainty (95% confidence interval [CI]) of the results of a meta-analysis. Data analysis was performed by Strata Software STATA 12.1 (StataCorp, Lakeway Drive Texas, USA).

RESULTS

Study selection and data collection

Two gynecologists (JT and SS), independently carried out the literature search, identified studies, and assessed their eligibility.

In total, 1076 published articles were found in the initial literature search. After reviewing these articles, total 145 articles were selected (15 articles from India, 42 from China, 46 from Korea, and 42 from Japan). The screening of records was done from 88 articles. Thirty-eight full-text articles were assessed for eligibility [Figure 1]. The final number of studies with full text available for analysis was 7 (74,897 participants). All the studies were cross-sectional type. The details of characteristics are shown in Table 1. There was one study from India and two each from China, Japan, and Korea.[5-11] Three studies each were hospital- and community-based, and one study was both hospital- and community-based. Six studies included both pre- and post-menopausal women and one study from china included only postmenopausal women. Bone marrow density (BMD) was measured in six studies

and speed of sound at calcaneus bone was measured in one study from Japan. Age ranges across different study were as 48–66 years. The range of prevalence was 15–68%. Pooled prevalence was 41.1% [Figure 2].

Various risk factors for osteoporosis observed in the seven selected studies are depicted in Table 2. In China, maximum risk factors were studied, but they were not studied in India, Korea, and Japan. Hence, for the final analysis, age, height, postmenopausal status, and exercise were considered.

Age as a nonmodifiable risk factor for osteoporosis was studied in all four countries, namely, India, China, Korea, and Japan. The pooled estimate for age in fixed-effect model was 1.10 (95% CI = 1.09–1.12), heterogeneity Chi-square = 78.47 ($P < 0.001$), and $I^2 = 93.6\%$. For the random-effect model, the pooled estimates were 1.15 (95% CI = 1.07–1.22) and heterogeneity Chi-square 78.47 ($P < 0.001$), $I^2 = 93.6\%$ [Figure 3].

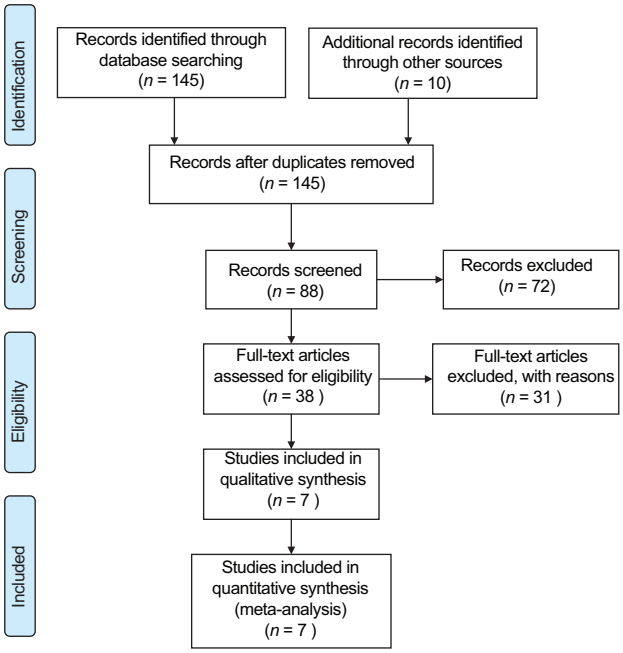

Figure 1: Details of the studies screened from India, China, Korea, and Japan from the year 2005–2014

Similarly, the pooled OR of height for fixed-effect model was 0.99 (95% CI = 0.96–1.02), and the heterogeneity was significant $P < 0.001$ $I^2 = 90.4\%$; for random effect model, OR was 1.01 (95% CI = 0.86–1.16), $P < 0.001$ and $I^2 = 90.4\%$ [Figure 4].

Age and height are risk factors osteoporosis. These factors cannot be modified for the prevention of osteoporosis.

For fixed-effect model, the pooled estimate for postmenopausal status was 2.14 (95% CI = 1.83–2.46), Heterogeneity Chi-square 2.78 $P = 0.43$; for the random-effect model, the pooled estimates are 2.14 (95% CI = 1.83–2.46). This states that in postmenopausal women there is 2-folds increase the risk of osteoporosis [Figure 5].

Exercise had shown a positive impact on osteoporosis. The pooled estimate for exercise for fixed-effect model was 0.52 (95% CI = 0.46–0.57). Heterogeneity Chi-square = 94.53 $P < 0.001$ $I^2 = 96.8\%$. Similarly, for the random-effect model 0.62 (0.26–0.98), heterogeneity Chi-square 94.53 $P < 0.001$ $I^2 = 96.8\%$ [Figure 6].

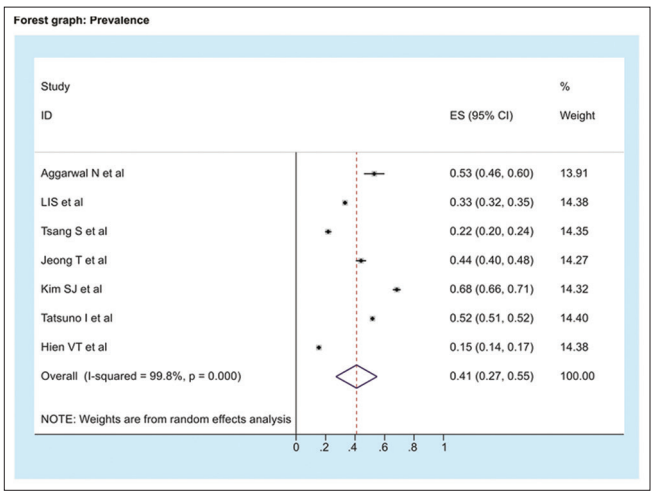

Figure 2: Forest plot showing pooled prevalence for osteoporosis in women from India, China, Korea, and Japan

Table 1: Characteristics of the cross-sectional studies

Name of first author	Name of country	Population involved	Number of participant	Prevalence (%)	Mean age±SD
Aggarwal *et al.*	India	Hospital and community based	200	53	52.50±5.94
Li *et al.*	China	Hospital based	4382	33.2	66.5±8.5
Tsang *et al.*	China	Community based	1372	21.8	66±10.1
Jeong *et al.*	Korea	Hospital based	759	44	57.5±6.7
Kim *et al.*	Korea	Hospital based	1143	68.3	62.0±9.7
Tatsuno *et al.*	Japan	Community based	64,809	51.8	56.9±9.9
Hien *et al.*	Japan	Community based	2232	15.4	48.5±16.5

SD: Standard deviation

Table 2: Risk factors studied in Asian countries

Risk factors	Name of country where risk factor was studied			
	India	China	Korea	Japan
Age	√	√	√	√
Height		√	√	√
Weight		√	√	
BMI		√	√	√
Age at menarche		√		
Age at menopause		√		
Postmenopause	√			√
Years since menopause		√		
Years since menopause				
Exercise	√	√		
Higher education		√		
Calcium supplements	√	√		
Low calcium intake		√		
Hypertension		√		
Total cholesterol level			√	
Diabetes mellitus		√		
Smoking		√		
Alcohol intake		√		
Previous history of fractures		√		

BMI: Body mass index

DISCUSSION

This review has shown that the prevalence of osteoporosis in India and neighboring Asian countries is 41%, but in India alone, it is 53%, which is higher and will become public health problem soon. Some preventable measures are necessary before it's become a major health issue in elderly population. Various risk factors are identified for the osteoporosis in women. Age, height, weight, BMI, and postmenopausal status are not modifiable in the elderly population. Hence, some modifiable factors should be identified to act as the preventable measures for osteoporosis. Exercise is the only preventable factor which is well studied in India and neighboring Asian countries.

The role of exercise in the prevention of osteoporosis had been discussed long back in 1980[12] but still there is no enough Indian literature to support which exercise is better and how long it should be done. Various types of exercises have been studied for the prevention of osteoporosis in women. These include resistance exercises, aquatic exercises, aerobic exercises, whole body vibration exercises, and balance exercises. Resistance exercises 3–4 times a week showed strengthening in back extensor muscles and a significant reduction in vertebral fracture and reduction in falls.[13] Aerobic exercises and simple walking improves femoral bone marrow density but have no effect on spine bone density.[14,15] Whole body vibrations also improve femoral bone density and considered superior to the walking.[16] Aquatic exercises are considered good

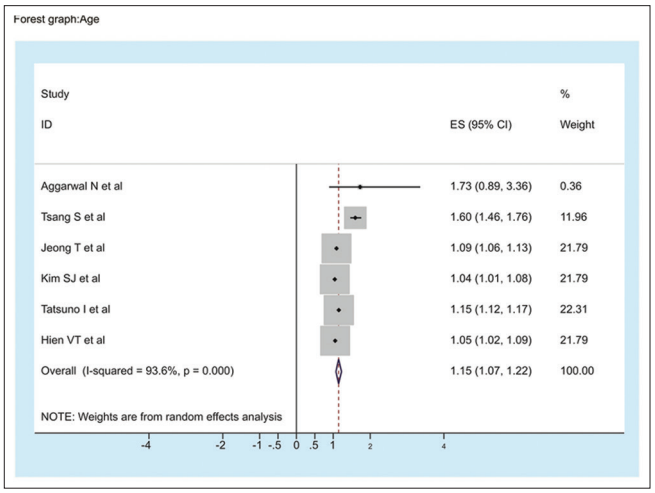

Figure 3: Forest graph showing relation of age with osteoporosis in women from India, China, Korea, and Japan

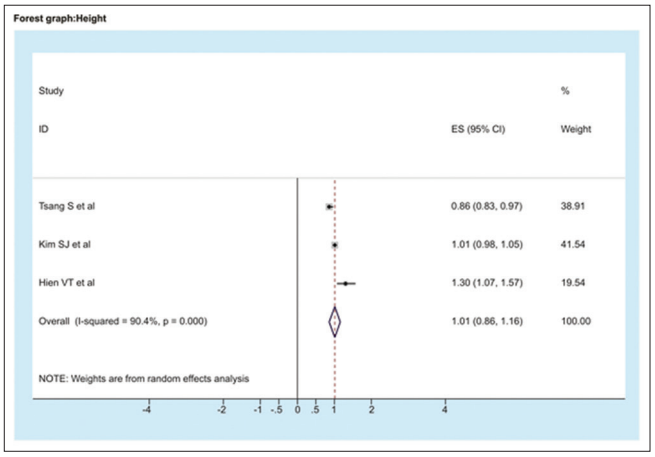

Figure 4: Forest graph showing relation of height with osteoporosis in women from China, Korea, and Japan

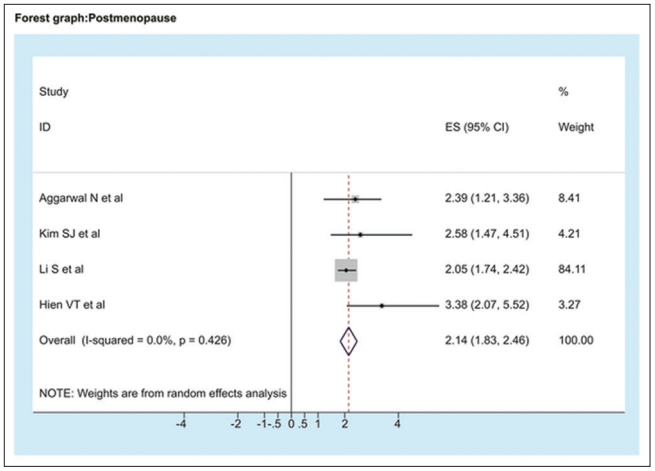

Figure 5: Forest graph showing relation of postmenopausal status with osteoporosis in women from India, China, Korea, and Japan

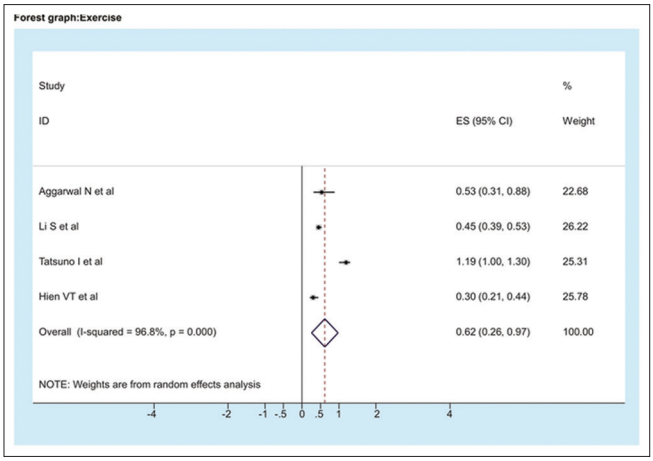

Figure 6: Forest graph showing relation of exercise with osteoporosis in women from India, China, and Japan

for balance and proprioception which will reduce falls and fractures.[17] Combined exercise program should be designed to take care of bone density of femoral neck, hip, and spines. At the same time, strengthening of muscles of legs and back should be considered for the prevention of falls.

Adequate calcium intake is another modifiable factor, which is also studied in India.[5] Calcium is the essential mineral for the formation of bone. Deficiency of calcium causes osteopenia and osteoporosis. A report by an expert group of Indian Council of Medical Research has shown that Indian diet does not meet the daily requirements of calcium of 600 mg/day.[18] Various other dietary components such as phytates interfere with the calcium absorption, and there is a deficiency in calcium rich diet. A study from china has also shown that dietary calcium intake <400 mg/day has shown that 2-folds increase in the vertebral fracture.[7] Adequate estrogen level and Vitamin D are necessary for the absorption of the calcium from the gut. Calcium causes mineralization of bone and improves BMD.

The natural source of Vitamin D is sunlight. Due to lifestyle factor, there is inadequate exposure to sunlight for the synthesis of Vitamin D.[19] Daily requirement of Vitamin D is 800–1000 IU. Several studies in India have shown that Indian population including young and old, women and men are deficient in Vitamin D.[19,20] In India, the supplementation of calcium, Vitamin D, and bisphosphonate are the commonly used drug for the prevention of osteoporosis in women.[21,22]

Adequate intake of calcium and Vitamin D and combination of various exercises should be considered for the prevention of osteoporosis.

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Conflicts of interest

There are no conflicts of interest.

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