



## ASSESSMENT OF RISK FACTORS FOR DEVELOPING OSTEOPOROSIS IN PRE- AND POST-MENOPAUSAL WOMEN

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### **ABSTRACT**

Osteoporosis is a serious health problem in population throughout the world. It is defined as a metabolic bone disease characterised by low bone mineral density and compromised bone strength that predisposes people to increased risk of fracture. A Cross-sectional research design was used in this study. 320 samples were included out of which 14 women consumed calcium supplements and 3 women were on Hormone Replacement Therapy (HRT). Thus, 17 women came under exclusion criteria and finally, 303 women were analysed and validated. The demographic and clinical variable was designed based on the reviews from literatures and experience. To assess the Bone Mineral Density (BMD), Osteoporosis Self-assessment Tool (OST) and QFracture®-2016 risk calculator were used to assess the prevalence of risk factors. A score was given to women based on number of calcium rich food they consume per day. The subject data was analysed using Microsoft Excel and Statistical Package for Social Sciences version 24. In our study, 303 samples were collected among who 196 (64.68%) belonged to the pre-menopausal category 107 (35.31%) belonged to the post-menopausal category. Considering QFracture risk calculation, both pre- and post-menopausal women reported majorly under  $\leq 10$  years with the frequency of 196 (100%) and 89 (83.18%).

Majority of the women in both pre- and post-menopausal category reported to have low risk for reduced BMD with the frequency of 194 (98.98%) and 76 (71.03%) respectively. A statistically significant difference was found in the Q-Fracture and BMD scores between pre- and post- menopausal women.

**Keywords** – Osteoporosis, Pre-menopause, Post-menopause, Fracture.

## INTRODUCTION

Osteoporosis is a serious health problem in population throughout the world. It is defined as a metabolic bone disease characterised by low bone mineral density and compromised bone strength that predisposes people to increased risk of fracture <sup>[1]</sup>. The social burden of osteoporosis is increasing gradually as the population ages, which is due to increased bone fragility and thus, increased probability of fracture. World Health Organisation (WHO) seeks for global strategy, which focuses on three functions like: prevalence, management and surveillance for the prevention and control of osteoporosis <sup>[2]</sup>.

Riggs and Melton classified osteoporosis by Type I (Primary) and Type II (Secondary). Type I is linked with a loss of androgen and estrogen which results in increased bone turnover, with bone resorption exceeding bone formation and prominent loss of trabecular bone compared with cortical bone. Type II is due to gradual age-related bone loss which is found both in men and women caused by systemic senescence. It is induced by the loss of stem cell precursors, with a prominent loss of cortical bone <sup>[3]</sup>. However, the pathological and clinical components of this classification was contradictory and is now seldom used. At present, the main risk factors being involved for the osteoporotic state is being used to classify <sup>[4]</sup>.

Ageing men of all races appear to lose bone from the proximal femurs at rates similar to those seen for comparable women. However, much fewer men than women develop very low levels of bone density, where fracture risk is greatest <sup>[5,6]</sup>. Increased longevity and increased proportion of Indian population over 50 years of age may lead to risk of developing osteoporosis in greater number of people. A study conducted in 2012 suggested that approximately 50 million people in India had *T*-scores of  $< -1$  <sup>[7, 8]</sup>.

Bone density also called as Bone Mineral Density (BMD) is that the relationship between two norms which is the *T*-score and the *Z*-score (the expected BMD for the individual's age and sex) <sup>[9]</sup>. The diagnostic criteria for osteoporosis are based on the BMD *T*-scores established

by WHO<sup>[10]</sup>. The T-scores represents the patient's BMD in terms of the number of Standard Deviations by which it differs from the mean peak value in young, healthy persons of the same sex<sup>[11]</sup>. For the purpose of diagnosis of osteoporosis, WHO uses a threshold of 2.5 SDs below the mean of young adult women. The criteria for the diagnosis of osteopenia (low bone mass) are more than 1.0 SD but less than 2.5 SDs below the reference mean<sup>[10]</sup>. However, T-scores were mainly developed for the estimation of the prevalence of osteoporosis not for the assessment of osteoporosis in specific patients<sup>[12]</sup>. Although, BMD is the standard test for the diagnosis of osteoporosis before treatment, research suggests it alone might not be sufficient to assess risk of fracture and efficacy of treatment<sup>[13]</sup>. Recently, The National Osteoporosis Foundation and The International Society for Clinical Densitometry consider central Dual X-ray Absorptiometry (DXA) of the hip and/or spine as the preferred measurement for osteoporosis diagnosis<sup>[14, 15]</sup>. Bone density as a criterion is employed as a proxy for overall bone strength and is expressed as grams of mineral per square centimetre or grams per cubic centimetre. As BMD declines, the risk of fracture increase has been demonstrated in the European Prospective Osteoporosis Study with increase in risk of fracture by a factor of 1.5 per 0.1g/cm<sup>2</sup> decline in the spinal BMD value<sup>[16]</sup>.

Peak bone mass is attained at the age of 30, after which men and women lose bone at a rate of approximately 0.3% and 0.5% per year, correspondingly. Especially bone loss in women is further accelerated by estrogen deficiency at a rate of 2% year during menopause and continues for 6 years thereafter<sup>[17]</sup>. The menopausal transition often begins between the ages of 45 – 55 and can last up to 7 years or as long as 14 years. This duration depends on various lifestyle factors like smoking, race, ethnicity, etc. In India the average age of menopause was found to be 46.5 years<sup>[18,19]</sup>. For the first few years after menopause, peak bone density is the major determinant of BMD<sup>[4]</sup>. In postmenopausal women, after cessation of ovarian function, the bone turnover rate raises dramatically and remains elevated for up to 40 years which leads to continuous, progressive bone loss. This increased bone turnover rate is due to shortened lifespan of osteoblasts and in turn prolonged lifespan of osteoclasts<sup>[20]</sup>. In addition to peak bone mass, ageing itself is a major risk factor for bone loss<sup>[10]</sup>.

Osteoporosis is acknowledged as the most prevalent disorder in the world. The risk factors for osteoporosis and osteoporotic fractures can be classified into two types as modifiable and non-modifiable<sup>[21]</sup>. Despite low BMD being an important predictor of future fracture risks, several studies show that there are many risk factors contributing to the fracture risk. The risk

factors include age, gender, ethnicity, diet, lifestyle, hormone status, bone loss, body mass index and medical comorbidities <sup>[22]</sup>.

If any situation that limits an individual's ability to maximise peak adult bone mass is present, it will increase the chance of developing osteoporosis in future. There are no safe and effective ways to rebuild osteoporotic bone and hence prevention is the key factor which must be considered <sup>[17]</sup>. Practically, menopause is the actual time when evaluation of the patient for osteoporosis begins, although nutritional and lifestyle habits should be changed as early in life as possible. Because most orthopaedists are exposed to a cross section of patients with respect to age, plays a dynamic role in osteoporosis in which prevention is feasible <sup>[23]</sup>. Osteoporosis as a condition is diagnosed only after the occurrence of a fracture. Our study can isolate the population at risk, bring awareness and thereby reduce the fracture rate.

## **MATERIALS AND METHODS**

A Cross-sectional research design was used. A total of 303 women aged  $\geq 31$  years were chosen as samples by simple random sampling technique and satisfied the inclusion criteria of the study. This study was conducted in and around Thoraipakkam, Chennai. The data collection included demographic variables and clinical variables to assess the bone mineral density. The study variable was Prevalence of risk factors for osteoporosis in Pre- and Post-menopausal women. The women were categorized in to pre-menopausal and post-menopausal women. The demographic variables include age, marital status, socio-economic status, fracture history, duration of exercise, type of diet, consumption of calcium rich foods, menstrual history, obstetric history and Clinical variables include height, weight and BMI.

### ***Criteria for sample selection***

Women residing in the selected area, who were willing to participate in the study and  $\geq 31$  years of age were included in the study. Women with no menstrual cycle for consecutive 12 months were considered as post-menopausal women. Those women who were taking calcium supplements, undergoing Hormone Replacement Therapy, having osteoporosis and psychiatric conditions were excluded from the study.

### ***Tools***

The Demographic and Clinical variable was designed by the investigator based on the reviews from literatures and experience. To assess the Bone Mineral Density, Osteoporosis Self-assessment Tool and QFracture®-2016 risk calculator were used to assess the prevalence of risk factors. A score was given to women based on number of calcium rich food they

consume per day.

### ***Method of data collection***

The objectives of the study were explained and informed verbally as well as written consent were obtained from the participants prior the start of the study. The study was conducted for 4 months and the samples were selected using non-probability random sampling technique. On a whole 320 samples were taken out of which 14 women consumed calcium supplements and 3 women were on Hormone Replacement Therapy (HRT). Thus, 17 women came under exclusion criteria and finally, 303 women were analysed and validated. The samples were explained about the purpose of the study and assured of the confidentiality of the data.

On selection of sample, self-introduction was given and brief of the study purpose was explained along with distribution of data collection tools. The patient required assistance in filling out the details required by the QFracture®-2016 risk calculator. Assistance was provided for further clarification needed by the subject and 10-15 minutes was consumed by each individual subject to complete the assessment.

### ***Statistical analysis***

The subject data was analyzed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 24. Continuous variable was presented as Mean  $\pm$  Standard deviation. Categorical variable was presented as frequency and percentage. Chi square test was performed to find out the differences in Q-Fracture and BMD score between pre- and post-menopausal women. P value  $< 0.05$  was considered statistically significant at a 5% level of significance to the confidence interval of 95%.

## **RESULTS**

In our study, 303 samples were collected among who 196 (64.68%) belonged to the pre-menopausal category 107 (35.31%) belonged to the post-menopausal category. The samples were assessed for various parameters, which is shown in Table 1. When BMI was considered majority of women were found to have normal weight in both pre-menopausal and post-menopausal category with the frequency of 74 (37.76%) and 48 (44.86%) respectively. Considering annual income, majority distribution was found between the category Rs.1,00,000 – 5,00,000 with the frequency of 126 (64.29%) and 60 (56.07%) in both pre- and post-menopausal category. Regarding education, majority of the women were under-graduated with the frequency of 76 (38.78%) in pre-menopausal category and in post-menopausal category majority of them were studied until high school with the frequency of 27 (25.23%).

**Table 1: Demographic details of the subjects**

Variable	Pre-menopausal women		Post-menopausal women	
	Frequency	Percentage	Frequency	Percentage
<b>Age</b>				
Severely underweight	2	1.02	1	0.93
Underweight	5	2.55	5	4.67
Normal weight	74	37.76	48	44.86
Overweight	73	37.24	73	68.22
<b>BMI</b>				
Severely underweight	2	1.02	1	0.93
Underweight	5	2.55	5	4.67
Normal weight	74	37.76	48	44.86
Overweight	73	37.24	36	33.64
Obesity	42	21.43	17	15.89
<b>Annual income</b>				
Less than 50,000	5	2.55	5	4.67
Rs.50,000 – 1,00,000	43	21.94	23	21.50
Rs.1,00,0000 – 5,00,000	126	64.29	60	56.07
Above 5,00,000	22	11.22	1	17.76
<b>Education</b>				
Primary school	9	4.59	23	21.50
Middle school	24	12.24	26	24.30
High school	38	19.39	27	25.23
Undergraduate	76	38.78	14	13.08
Postgraduate	49	25.00	17	15.89

Considering past medical history, in both pre- and post-menopausal category, Hypothyroidism was the major medical condition women had with the frequency of 25 (12.76%) and 21 (19.63%). Regarding past medication history, only few consumed anticonvulsants, antidepressants and steroids in both categories. Out of which, majority of the women in pre-menopausal category consumed antidepressants and steroids with the frequency of 3 (1.53%) equally but in post-menopausal category, majority of them consumed steroids with the frequency of 3 (2.80%) which is shown in Table 2.

**Table 2: Clinical details of the subjects**

Variable	Pre-menopausal women		Post-menopausal women	
	Frequency	Percentage	Frequency	Percentage
<b>Past medical history</b>				
Angina	0	-	2	1.87
Asthma	10	5.10	5	4.67
Cancer	0	-	2	1.87
Celiac disease	2	1.02	0	-
Chronic Kidney Disease	1	0.51	1	0.93
Chronic liver disease	1	0.51	0	-
Dementia	0	-	0	-
Hypothyroidism	25	12.76	21	19.63
Parkinson's disease	0	-	1	0.93
Rheumatoid arthritis	2	1.02	4	3.74
T1DM	1	0.51	2	1.87
T2DM	12	6.12	18	16.82
Hyperthyroidism	1	0.51	0	-
<b>Past medication history</b>				
Anticonvulsants	2	1.02	0	-
Antidepressants	3	1.53	0	-
Steroids	3	1.53	3	2.80

In the family history of osteoporosis, majority of the women in both pre- and post-menopausal category reported “No” with the frequency of 166 (84.69%) and 93 (86.92%) respectively. When considering history of falls, both the category reported majorly “No” with the frequency of 169 (86.22%) in pre-menopausal and 99 (92.52%) in post-menopausal category. Regarding history of fracture, majority of the women in both pre- and post-menopausal category reported “No” with the frequency of 179 (91.33%) and 84 (78.50%). Duration of exercise in minutes was categorised into 6 groups, out of which, in both pre and post-menopausal category, majority of the women reported “nil exercise” (0 minutes) with the frequency of 95 (48.47%) and 64 (59.81%) respectively. Regarding the type of diet, majority of the women were non-vegetarians in both pre- and post-menopausal category with

the frequency of 157 (80.10%) and 67 (62.62%). Dietary calcium intake was categorised according to scores from 1 to 6, out of which, majority of the women in both pre- and post-menopausal category came under score 3 with the frequency of 64 (32.65%) and 48 (44.86%) as elaborated in Table 3.

**Table 3: Fracture and Dietary history**

Variable	Pre-menopausal women		Post-menopausal women	
	Frequency	Percentage	Frequency	Percentage
<b>Family history of osteoporosis</b>				
Yes	30	15.31	14	13.08
No	166	84.69	93	86.92
<b>History of falls</b>				
Yes	27	13.78	8	7.48
No	169	86.22	99	92.52
<b>History of fracture</b>				
Yes	17	8.67	23	21.50
No	179	91.33	84	78.50
<b>Duration of exercise</b>				
0	95	48.47	64	59.81
<15	12	6.12	8	7.48
15-30	60	30.61	22	20.56
30-45	8	4.08	6	5.61
45-60	4	2.04	0	-
>60	17	8.67	7	6.54
<b>Type of diet</b>				
Vegetarian	38	19.39	40	37.38
Non-vegetarian	157	80.10	67	62.62
Vegan	1	0.51	0	-
<b>Dietary calcium intake</b>				
1	21	10.71	10	9.35
2	52	26.53	28	26.17
3	64	32.65	48	44.86
4	35	17.86	16	14.95
5	18	9.18	3	2.80
6	6	4.05	2	1.87

Considering the regularity of menstrual of cycle, both pre- and post-menopausal category reported majorly regular cycles with the frequency of 176 (89.80%) and 96 (89.72%). Regarding the number of children, majority of them had 1-2 children with the frequency of



158 (80.61%) in pre-menopausal and 68 (63.55%) in post-menopausal category as shown in Table 4.

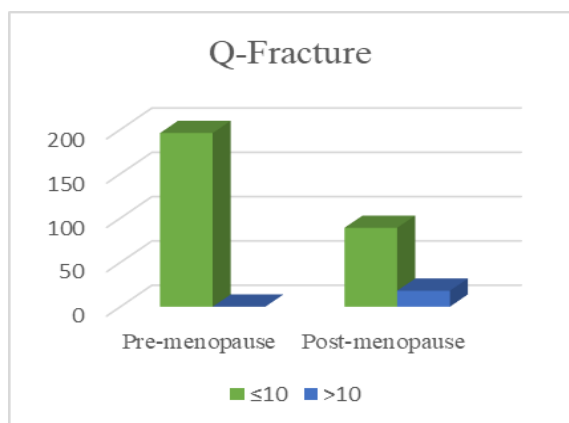
**Table 4: Reproductive history**

Variable	Pre-menopausal women		Post-menopausal women	
	Frequency	Percentage	Frequency	Percentage
<b>Regularity of menstrual cycle</b>				
Regular	176	89.80	96	89.72
Irregular	20	10.20	11	10.28
<b>No. of children</b>				
0	21	10.71	4	3.74
1-2	158	80.61	68	63.55
3-5	17	8.67	29	27.10
>5	0	-	6	5.61

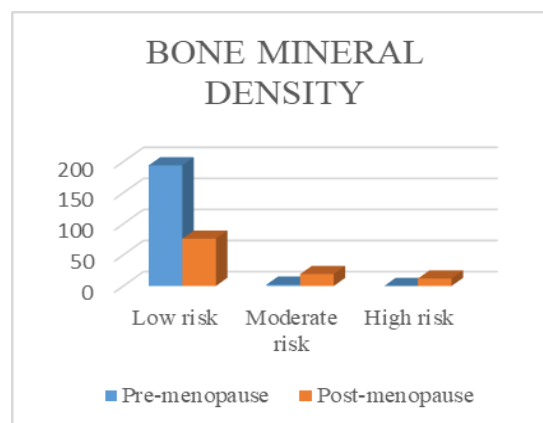
Considering Qfracture risk calculation, both pre- and post-menopausal women reported majorly under  $\leq 10$  years with the frequency of 196 (100%) and 89 (83.18%). BMD was categorised into low, moderate and high risk. Majority of the women in both pre- and post-menopausal category reported to have low risk with the frequency of 194 (98.98%) and 76 (71.03%) respectively as shown in Table 5.

**Table 5: Q Fracture and BMD score**

Variable	Pre-menopausal women		Post-menopausal women		P value
	Frequency	Percentage	Frequency	Percentage	
<b>Q-fracture</b>					
$\leq 10$	196	100.00	89	83.18	<0.0001*
>10	0	-	18	16.82	
<b>BMD</b>					
Low risk	194	98.98	76	71.03	<0.0001*
Moderate risk	2	1.02	19	17.76	
High risk	0	-	12	11.21	



**Figure 1: Q-Fracture**



**Figure 2: Bone Mineral Density**

## DISCUSSION

Osteoporosis is a common health problem that can cause weak bones and lead to fractures. In our study, most women exhibited symptoms for osteoporosis but were not clinically diagnosed. It is estimated that approximately 50 million people in India had osteopenia which could develop into osteoporosis in the future. Many factors pose as a risk for osteoporosis. Most people are diagnosed with osteoporosis only after the incidence of fracture <sup>[2]</sup>. For this reason, it is important to determine the individuals with the risk factors for osteoporosis as a preventative approach.

We have categorized women into pre-menopausal and post-menopausal category based on their menstrual status. This categorization was done to highlight the posing risk factors in women due to the modern and sedentary lifestyle. In our study most pre-menopausal women complained about symptoms of osteoporosis but it is often overlooked.

Age is an important non-modifiable risk factor. In our study, 44.55% of women were under 41- 50 years and 14.19% were above 60 years of age. Mean age of our population was found to be 48 years with a standard deviation of 11.08. It is a common misconception that there is a progressing linearity between age and osteoporosis symptoms. With age not being the primary contributing factor for this population, it urges us to explore other risk factors that may be present. The mean age for pre-menopausal category was 41.77 and for post-menopausal category was 59.69. Kim J, et al., (2021) found that individuals who were underweight or obese had higher rates of fracture when compared with normal weight groups <sup>[24]</sup>. In the current study, in the pre-menopausal category 21.43% of women were obese and 2.5% were underweight. In the post-menopausal category 15.89% were obese and 4.67%

were underweight. These individuals were found to be at a risk for developing osteoporosis than others.

Fabiani R, et al., (2019) reported that vegetarian diet is associated with reduced risk of developing osteoporosis and fractures than non-vegetarian diet <sup>[25]</sup>. In pre-menopausal women 80% of them consumed non-vegetarian diet and 19.39% consumed vegetarian diet. 4.05% had a dietary calcium score of 6 and thus they may have a reduced risk of developing osteoporosis than the rest of our study population. In post-menopausal women 62.62% were found to consume non-vegetarian diet and 37.38% of women were found to consume vegetarian diet. 1.87% of women had a dietary calcium score of 6 and are less likely to develop osteoporosis than others.

Silman AJ, et al., (2003) revealed that a late menarche greater than 15 years was found to be a risk factor for osteoporosis <sup>[26]</sup>. In the pre-menopausal category 17.35% of women had a later menarche age. In post-menopausal category 60.82% of women attained menarche after 15 years.

Physical inactivity is a modifiable risk factor for osteoporosis. In the pre-menopausal category 48.47% were found to be physically inactive. In the post-menopausal category 59.81% of women did not undertake any physical activity. Hence, they were found to have a higher risk of developing osteoporosis than other individuals.

In the current study, according to the Q-Fracture risk calculator all the women in the pre-menopausal category had a Q-Fracture score of less than 10% and hence they are hypothesised to have a lesser risk of developing fracture than post-menopausal women among who 16.82% of women had a Q-Fracture score of greater than 10%. When OST score was calculated no high risk, individuals were found in the pre-menopausal category and in the post-menopausal category 11.21% of women were found to have a high risk of developing low bone mineral density which can lead to future fractures. Statistically significant difference was found in QFracture and BMD scores between pre- and post-menopausal women (p-value <0.0001\*). So, they were advised to consult an orthopaedist to prevent the incidence of osteoporosis in the future.

## CONCLUSION

The incidence of osteoporosis is more common in women than in men due to many factors such as early bone resorption, low calcium intake, estrogen deficiency and pregnancy. In

India, 6 out of 10 fractures and bone injuries are caused by osteoporosis. Osteoporosis shows no symptoms and unfortunately is diagnosed only after a fracture by the time the patient may have suffered considerable bone loss. From our findings, we conclude that majority of our study population were at a lower risk of developing osteoporosis or osteoporotic fractures. Even though prior symptoms for an imminent fracture are not common, BMD and other risk factors can pin down high-risk patients. More awareness should be created regarding the importance of bone health among all categories of women and should not pertain only to women in the post-menopausal category.

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