

## Original Research Article

# A comparative study between calcium intake and low bone density among women (19-35 year) in urban area of Hyderabad, India

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## ABSTRACT

**Background:** This paper is aimed at assessment of bone health in women aged between 19-35 years in the urban area leading a sedentary lifestyle. The objective of the study was to assess the bone density among the adult women and identify their risk of developing osteoporosis and to associate risk factors that may predispose them to osteoporosis.

**Methods:** The methodology involved assessment of their anthropometric measurements and calculating Body mass index to identify obese and non-obese participants. A semi-quantitative food frequency questionnaire was framed to know the calcium intake of the diet along with the other nutrients and foods that favour and hinder the absorption of calcium was also studied along with their frequency of consumption. BMD test on all 51 participants is done and the T- score obtained compared with the WHO classification.

**Results:** It was observed that 35% of the participants were having osteopenia, a condition where bones become weak than normal and may predispose to osteoporosis. The calcium content of the diet found to be lower than the RDA which is significant at  $p < 0.05$ . Correlation analysis showed a weak negative correlation between the two variables i.e., calcium intake and bone mineral density  $r = -0.03$ ,  $p > 0.05$ . Other factors that can contribute to the low bone mineral density was lack of exercise, obesity, genetic inheritance, H/o PCOS, hypothyroidism, consumption of coffee and carbonated beverages.

**Conclusions:** Thus, it is concluded that these women are at risk of developing osteoporosis so dietary modification and change in lifestyle is necessary.

**Keywords:** Bone mineral density, Calcium deficiency, Osteoporosis, Osteopenia

## INTRODUCTION

The skeletal system is one of the largest organs in the human body. The conventional functions of the skeleton include supporting body movements as structural organ, protect or safeguard the internal organs and minerals reservoir.<sup>1</sup> Bone mainly consists of calcium and phosphorus in a certain volume. Bone mineral density or BMD measurements are a great tool to diagnose low bone density resulting in osteopenia or osteoporosis which are marked by a decrease in bone mass, BMD measurement also used to predict the fate of osteoporosis treatment and

how likely the of risk of bone fractures are associated with individuals.<sup>2</sup>

Osteoporosis is recognized as a major public health problem in developing and developed nations. It is characterized by bone loss, micro architectural deterioration, and compromised bone strength. It may lead to bone fragility and propensity for fracture particularly in postmenopausal women.<sup>3</sup> BMD measurements are considered as one of the preferred methods of testing bone mineral density using DEXA /DXA scan of the central skeleton i.e. lumbar spine and

hip, apart from this some minor points like heel, wrist and fingers are also considered for scan and for predicting the risk of hip fracture, as values generated can easily be elucidated using WHO T score definition of osteoporosis and osteopenia.<sup>1,4</sup>

### **WHO fracture risk algorithm**

BMD is used as an important factor determining the risk of the patient having fracture within the next 5-10 year, BMD scan has several advantages including targeting osteoporosis treatment according to patient's risk fracture. BMD is dependent on many factors which include gender, ethnicity, BMI and age.<sup>5</sup> Clinical risk factors included in WHO fracture risk algorithm (FRAX) are age, low body mass index, prior fracture after age 50, parental history of hip fracture, current smoking habit current or past use of systemic corticosteroids, alcohol intake >2 units daily and rheumatoid arthritis.

### **Clinical role of bone density measurements**

In recent years' measurement of bone density, BMD is playing important role in the evaluation of the prevalence of osteoporosis in fracture treatment DEXA scans have three major key roles in clinical practice i.e. diagnosis of osteoporosis, assessment of patient's risk of fracture and monitoring response to treatment.<sup>4</sup> Apart from this DEXA scans have various advantages over other methods like quantitative computed tomography QCT measurements and quantitative ultrasound devices. These advantages include BMD results can be interpreted using WHO T-scores, basis of new WHO algorithm for predicting fracture risk, good precision, acceptable accuracy short scan time, rapid patient set up, low radiation dose, and availability of reliable reference ranges. This tool is widely used for conducting epidemiological studies.<sup>5-7</sup> In this study, BMD for adult females in their reproductive age is taken to carry out the association between the calcium intake and bone health. Bone density reaches peak accretion of calcium by the age of 30. Thus calcium, protein, vitamin C, and vitamin D nutriture is important in an individual to prevent bone loss in the subsequent years.

## **METHODS**

### **Characteristics/ selection of subjects**

51 healthy women, non-pregnant, non-lactating (NPNL) were selected via random sampling method for the study. The study was conducted in an institution in the month of December 2018 for about 3 days. All subjects were Asians and only 9 subjects possess health issues like Polycystic ovarian syndrome and hypothyroidism. Post-menopausal women were excluded from the study. After explaining study design, they were provided with an information sheet consists of a detailed methodology of the study, pros and cons along with possible risk factor associated with the study. A written consent using

guidelines of WMA declaration of Helsinki ethical principles for medical research involving human subjects was framed and countersigned by participants and collected.

### **Data collection**

A self-administered questionnaire was given to all participants to gather information related to their socio-economic condition, medical history, family background, dietary history. Food Frequency Questionnaire was also recorded to assess dietary intakes of nutrient like protein, calcium, and vitamin C and Nutritive content of the diet was calculated.

### **Measurement of bone mineral density**

All participants underwent DEXA/ DXA scan to assess bone density at heel using DXA GE Model 4.500W model. The scan was done by trained personnel from a well reputed diagnostic centre, following manufacturer instructions. Results were obtained in terms of T-score as recommended by WHO (Table 1), by a computer attached to the scanners. All reports were computer-generated.

**Table 1: WHO definition of osteoporosis and osteopenia.**

| Terminology                     | T-score definition   |
|---------------------------------|--|
| <b>Normal</b>                   | T $\geq$ - 1.0 and above                                     |
| <b>Osteopenia</b>               | T < -1.0 to -2.5   |
| <b>Osteoporosis</b>             | T $\leq$ -2.5  |
| <b>Established osteoporosis</b> | T $\leq$ -2.5 in presence of one or more fragility fractures |

### **Statistical analysis**

The data obtained from the food frequency questionnaire was analyzed and checked for the deviation from the recommended dietary allowance for nutrients and the frequency of consumption was known. One sample student's T-test was applied and checked for the Critical value at 5% significance in Ms Excel. The study also assessed the association between the low calcium intake and low BMD T score. Spearman's Rank Correlation was applied to study the relationship between the two variables 2 tailed Rho value at 5% of significance.

## **RESULTS**

### **Analysis of subject profile**

The participants were categorized into three groups within a common range of age as 19-25years (39), 25-30 years (9) and 30-35 years (3) for the ease of analysis. Body mass index of the participants was calculated which revealed 76% of the subjects were having a normal BMI with mean value as  $22.8 \pm 5.4$  kg/m<sup>2</sup> and 23.5% were obese (Table 2).

**Table 2: Anthropometric data.**

| Age (year) | No. of subjects | Standard height (cm) | Mean±SD    | Standard weights (kg) | Mean±SD   | Standard BMI kg/m <sup>2</sup> | Mean±SD  |
|------------|-----------------|----------------------|------------|-----------------------|-----------|--------------------------------|----------|
| 19-25      | 39              | 152.3                | 157.3±7.10 | 45                    | 56.2±11.2 | 18.5 - 22.9                    | 22.8±5.4 |
| 25-30      | 9               | 152                  | 156.6±4.0  | 46.2                  | 65±8.66   | 18.5 - 22.9                    | 26.4±2.9 |
| 30-35      | 3               | 151.7                | 154        | 47.7                  | 65        | 18.5 - 22.9                    | 27.4     |

**Table 3: Mean food intake per day (g/ml).**

| Food                        | Standard portion** | Mean food intake | SD     | T-value | P value  |
|-----------------------------|--------------------|------------------|--------|---------|----------|
| Cereals (whole and refined) | 270g               | 90               | 76.48  | 9.714   | 0.00001* |
| Pulses                      | 30 g               | 17.64            | 23.85  | 2.136   | 0.024*   |
| Glv's                       | 100 g              | 100              | 136.93 | 0       | 5        |
| Other vegetables            | 200 g              | 311.76           | 145.26 | 3.171   | 0.00296* |
| Fruits                      | 100 g              | 41.17            | 50.72  | 4.788   | 0.0001*  |
| Dairy products              | 300 g              | 35.29            | 49.25  | 5.417   | 0.00002* |
| Fleshy foods                | 50 g               | 50               | 66.14  | 0       | 5        |
| Coffee/caffeine             | 300mg <sup>8</sup> | 12.75            | 31.4   | 37.68   | 0.00001* |
| Carbonated beverages        | 700ml <sup>9</sup> | 4.13             | 9.27   | 20.4    | 0.00001* |

\* values significant at 0.05, critical value 1.746

It was also noted that the subjects were non-Alcoholic, non-smoker, and having a good appetite. 11.7% (6) participants reported a family history of osteoporosis and usage of thyroxine tablets which can validate the decrease in the bone density and risk of developing osteoporosis in future. No consumption of antacids, anticonvulsants and corticosteroids medications was reported. No medical history of chronic liver disease, malabsorption syndrome, gastrointestinal diseases, hyperparathyroidism was seen among them.

#### Analysis of food frequency questionnaire

It was observed from the data obtained from the questionnaire that there is lack of calcium sources in the diet when compared with the RDA. The mean intake of calcium per day in the diet was found to be 324.0±143.5 mg which shows a significant difference at  $p < 0.05$  (Table 3). The intake of calcium supplements among the participants was found to be less i.e., 11.7% of the participants used calcium supplements occasionally.

**Table 4: BMD values in percentages.**

| T-score for BMD     | No. of subjects | %    |
|---------------------|-----------------|------|
| T ≥ - 1.0 and above | 33              | 64.7 |
| T < -1.0 to -2.5    | 18              | 35.2 |
| T ≤ -2.5            | 0               | 0    |

Finally, the BMD values were obtained and compared with the WHO classification of BMD T- score, 18 (35%) participants were found to be osteopenic and the rest were having a normal BMD score as seen in Table 4.

## DISCUSSION

The findings of the study reveal that there is significant less intake of calcium (mean intake 324.0±143.5) than the recommended allowances among the participants which is also shown from their bone mineral density test (35%). It can be drawn from the anthropometric measurements that majority of participants were maintaining ideal BMI and 23.5% were in the category of obesity. A study conducted by Kim et al shows an association of bone mineral density with increased body fat percentage in normal- weight subjects.<sup>10</sup> Another study by Mohammed Reza Salamat et al., showed BMI and osteopenia association in overweight/obese and normal-weight men.<sup>11</sup> Overweight and thin individuals or those who lost 10% or more bodyweight might be at risk of osteoporosis.<sup>12</sup> Thus, people are at risk of low bone mineral density irrespective of their BMI's. Overall if obesity is defined in terms of body fat per cent then obese participants may be are at risk for osteoporosis.<sup>11</sup>

**Table 5: Comparison of protein, calcium and vitamin C mean intake with RDA.**

| Nutrient  | RDA**  | Mean ± SD   | T-value | P value   |
|-----------|--------|-------------|---------|-----------|
| Protein   | 55 g   | 32.0±22.2   | 4.27    | 0.000292* |
| Calcium   | 600 mg | 324.0±143.5 | 7.93    | 0.00001*  |
| Vitamin C | 40 mg  | 82.7±47.7   | 3.69    | 0.0009*   |

\*\*RDA for adult female sedentary worker 2010. ICMR, \* values are significant at  $p < 0.05$

From the food frequency questionnaire, other nutrients were also assessed like protein, vitamin C and other dietary constituents such as caffeine and phosphoric acid

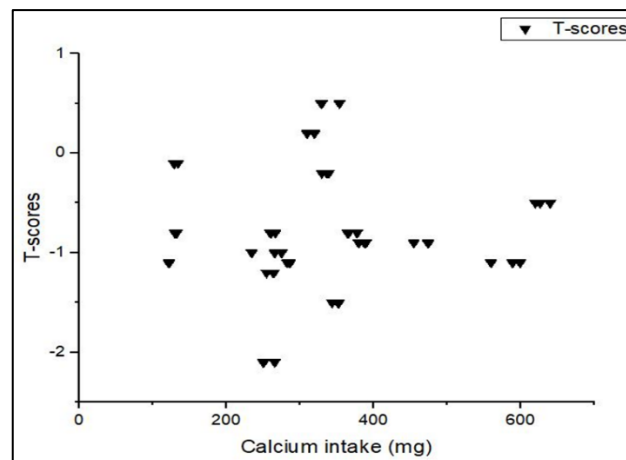
from carbonated beverages all these factors have a moderate correlation with osteoporosis (Table 5).<sup>9</sup>

The effect of crude fibre on calcium absorption is not clear hence it is not studied. The consumption of whole grains was also found to be low hence phytic acid content is low as well. Vitamin C is known to enhance intestinal calcium absorption. The mean intake of vitamin C is found to be higher than the recommendation made by ICMR in RDA i.e.,  $82.7 \pm 47.7$  mg. In 15 (29%) participants, the consumption of proteins from fleshy foods is found to be twice and thrice a day. Some studies have shown that excessive consumption from meat may increase the risk of osteoporosis.<sup>13</sup> Increased protein intake is reported to increase the excretion of calcium in urine.<sup>13</sup> The mean intake of protein is found to be  $32 \pm 22.2$ g. High protein can affect calcium absorption when the amount of calcium intake is low in diets which are seen in these participants'. Not all participants consumed coffee but 9 (17.6%) participants have a daily consumption twice and thrice a day. The mean caffeine content from coffee is found to be  $12.7 \text{mg} \pm 31.4 \text{mg}$  and it is also derived from cola beverages which range between 50mg to 500 mg.<sup>14</sup> A caffeine level of 300mg is considered safe and a high intake of caffeine affects the bioavailability of calcium. Daily consumption of 3.5 cups of coffee and 7 cups of tea can interfere with normal bone remodelling. Similar results were found with carbonated beverages with a mean intake of  $4.13 \pm 9.27$  mg. A carbonated beverage contains caffeine and phosphate ions which can bind to calcium in the GI tract. A consumption of 700ml or more volume cans and bottles per day can increase the incidence of bone fractures. The amount of phosphorus absorbed from food additives is as high as 90% as the natural sources.<sup>15</sup> Phosphorus as an additive in carbonated beverages is in the form of phosphorus salts which is readily absorbed in the intestinal tract. In the present study, the intake of carbonated beverage is not higher on daily basis. The results are found to be significant at  $p < 0.05$ .

77% participants were involved in non-weight-bearing exercise like walking and 23% were not involved in any physical exercise which indicates loss of almost 0.5% of bone per month.<sup>13</sup>

The other objective of the study was to assess the correlation between the low calcium intake to low BMD score. Spearman's Rank correlation was used as a statistical tool to deduce the correlation between them. The calcium intake of every individual was correlated with their respective BMD t- scores. The correlation between the calcium intake and BMD t-scores were weakly negative correlated  $r_s = -0.03$ ,  $p \geq 0.05$  shown in Figure 1. It can be considered from the correlation that various factors affect bone health and not just calcium intake. In this study the factors that can affect the bone health apart from low calcium intake are low physical activity, low levels of oestrogen as some participants have a medical history of PCOS, on thyroid hormone

medications and to some extent consumption of caffeine and carbonated beverages contribute to overall low bone health in osteopenic participants.



**Figure 1: Correlation between calcium intake and BMD T-score.**

Scatterplot shows weak and negative correlation between the two variables.

### Limitations

The present study has its own limitations with regards to the sample size, also analysing various others factors and co relating it with the Bone mineral density tests.

### CONCLUSION

It can be concluded from the study that the intake of calcium among the participants was found to be lower than the RDA at  $p < 0.05$  significance. Thus, it is of utmost importance to create awareness about their risk of osteoporosis in future.

All the factors contribute to low bone density, but in the study only the correlation between calcium intake and BMD scores were done which were weakly correlated. Various studies on correlation related to bone health when analyzed were found to have inconsistencies and limitations. Thus, prospective studies are needed to strongly support the relationship between calcium intake and the other various factors associated with bone health and osteoporosis.

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