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POPULATION-BASED STUDY

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# SUNLIGHT EXPOSURE, DIETARY CALCIUM INTAKE AND ITS ASSOCIATION WITH OSTEOPOROSIS RISK IN PERI AND POSTMENOPAUSAL WOMEN: A POPULATION-BASED STUDY

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**ABSTRACT:** Osteoporosis is a multifactorial condition and affects approximately 18.3% of the global population particularly in developing countries. The modifiable risk factors include adequate intake of calcium and vitamin D, physical activity and the non-food source of vitamin D (skin synthesis through exposure to sunlight). However, limited population-based research has been conducted regarding dietary calcium intake and natural exposure to sunlight as an intervention to prevent osteoporosis in postmenopausal women. This research aiming to study sunlight exposure per day in 620 perimenopausal and 590 post-menopausal women (40 to 61 years) in Mumbai, Hyderabad and Bidar. Validated sunlight exposure questionnaire includes information on participant's exposure to sun (from 8 a.m. to 5 p.m.) and sun protection measures, use of sunscreens, and wearing cap. Validated semi-quantitative food frequency questionnaire (SFFQ) was used to collect information on participant's frequency and quantity of food intake. According to the findings of the study, majority of perimenopausal women [Mumbai (84%), Hyderabad (61.2%), Bidar (96.2 %)] and post-menopausal women [Mumbai (88%), Hyderabad (64.7%), Bidar (98.6 %)] had sun exposure less than fifteen minutes per day with 15% exposure of skin area, which was inadequate as per clinical practice guidelines on Menopause (2020). The mean dietary calcium intake was inadequate for both groups, for perimenopausal meeting only (Mumbai- 68.4%, Hyderabad-65.7%, Bidar-55.3%) of EAR and (Mumbai- 54.7%, Hyderabad-52.6%, Bidar-44.2%) of RDA and postmenopausal meeting only (Mumbai-52%, Hyderabad-48.4%, Bidar-49.5%) of EAR and (Mumbai- 43.3%, Hyderabad-40.3%, Bidar-41.2%) of RDA. The OSTA score and sunlight exposure showed statistically significant difference between perimenopausal and post-menopausal women [Mumbai ( $t=3.788$ ,  $p=0.000$ ) Hyderabad ( $t=-4.193$ ,  $p=0.000$ ) Bidar ( $t=-7.778$ ,  $p=0.000$ )]. The study concludes that a significant proportion of postmenopausal women have inadequate sunlight exposure combined with low dietary calcium intake. There is need to educate women in both the groups about exposure to sun for good bone health along with nutrition to avoid osteoporosis risk.

**KEYWORDS:** Sun exposure, Dietary calcium intake, perimenopausal, post-menopausal

## **1. INTRODUCTION:**

Menopause is considered a transition phase from the reproductive to the non-reproductive phase in a woman's life<sup>[4]</sup>. Menopause is characterized as a period that occurs after 12 months of amenorrhea. During Menopause, falling oestrogen could also interfere with the ability of the bones to retain calcium. Estrogen-androgen -deficient post-menopausal osteoporosis (PMO)

occurs in women within a few years of menopause from loss of trabecular bone tissue and cessation of ovarian production of estrogens.<sup>[14]</sup>

Vitamin D helps regulate the deposition of calcium and phosphate into bone tissue, promoting bone mineralization and strength. Insufficient vitamin D can lead to defects in bone mineralization, resulting in brittle and weak bones. Osteoporosis is entirely preventable by measures like good exposure to sunlight along with adequate calcium intake. The time of the day and duration of exposure to sunlight is very important for sufficient vitamin D synthesis <sup>[13]</sup>.

The present study was designed to assess sun exposure in Perimenopausal and Postmenopausal Women aged between 40-61 years from different socioeconomic strata in Mumbai, Hyderabad, and Bidar by using a validated sunlight exposure questionnaire <sup>[17]</sup>. The secondary objective was to find out association between sun exposure and dietary intake of calcium(mg/day) in perimenopausal and postmenopausal women from different socioeconomic strata in Mumbai, Hyderabad, and Bidar by using a validated semi-quantitative food frequency questionnaire (SFFQ) <sup>[12]</sup>.

### **Objectives-**

**Primary objective:** To assess sun exposure in Perimenopausal and Postmenopausal Women of Mumbai, Hyderabad and Bidar by using validated sun exposure questionnaire <sup>[17]</sup>.

**Secondary objective:** To correlate sun exposure and dietary intake of calcium(mg/day) in Perimenopausal and Postmenopausal Women of Mumbai, Hyderabad and Bidar <sup>[12]</sup>.

### **2.REVIEW OF LITERATURE:**

Menopause is a phase in women's life when menstruation comes to an end. It has been observed the issues of Indian women include an early age of natural menopause. Postmenopausal women are often at an increased risk of developing primary osteoporosis due to estrogen deficiency <sup>[13]</sup>.

Osteoporosis is a systemic skeletal disease characterized by low bone mineral density (BMD) and increased susceptibility to fractures <sup>[13]</sup>. There are many techniques available to assess bone mineral at multiple sites including those where osteoporotic fractures are predominantly occurs. Dual energy X-ray absorptiometry (DXA) considered validated method of BMD measurement <sup>[16]</sup>. Due to cost and lack of equipment, BMD measurements are not widely available. Therefore, various tools and questionnaires have been developed to simplify the risk assessment process where Dual energy X-ray absorptiometry (DXA) may not be readily available. The Osteoporosis Self-Assessment Tool for Asians (OSTA) was first developed as a simplified method to assess the risk of osteoporosis in Asian populations in 2001<sup>[9]</sup>.

Osteoporosis is caused due to an inadequate intake of dietary calcium and vitamin D, the non-food source of vitamin D, which is skin synthesis through exposure to sunlight and lack of physical activity. vitamin D plays a critical role in maintaining calcium homeostasis and bone health, especially in older adults. A woman's calcium requirement increases at menopause

because calcium absorption efficiency and renal conservation are both estrogen-dependent, and both deteriorate in the estrogen-deprived state. Incorporating calcium-rich foods into each meal or snack is a simple and effective way to meet daily calcium requirement. Approximately 1 glass/ cup of 250 ml of dairy products daily provides the 300-mg of calcium which is the recommendation <sup>[14]</sup>.

Vitamin D synthesized in the skin lasts two-times longer in the body. Vitamin D is often referred to as a "vitamin," but it behaves more like a hormone in the body, and its production is primarily initiated by exposure to sunlight rather than being obtained solely through dietary sources like other vitamins <sup>[11]</sup>.

The reasons for vitamin D deficiency among Indians may be lower sun exposure due to indoor lifestyle habit, traditional clothing leading to less skin exposure to sunlight (saris, salwar kameez, etc.), inadequate dietary intake as well as poor vitamin D fortification of foods, and darkly pigmented skin and atmospheric pollution Vitamin D deficiency results in ineffective calcium absorption from the gut <sup>[15]</sup>.

As per Indian Menopause Society guidelines (2020) to get sufficient vitamin D3{(25microgram(1000IU)} through sun, exposure of 20% skin (face, neck, both arms and forearms) without sunscreen for at least 30 minutes between 10 am to 3 pm is required depending on the season, latitude, altitude, pollution, and skin pigmentation. This exposure is equivalent to producing 340–490 IU of Vitamin D every day according to the reports that 100 IU of Vitamin D intake will raise serum 25(OH)D by 1 ng/ml <sup>[13]</sup>.

This study will attempt to identify sunlight exposure and consumption of dietary calcium intake contributing to osteoporosis in perimenopausal and post- menopausal women of Mumbai, Hyderabad and Bidar so that community-based interventions can be planned for this group of women.

### **Need for the Study:**

1.Many hospitals based and clinical studies examined the prevalence of osteoporosis and vitamin D deficiency due to low sun exposure in general population of India but very few population-based studies to date done among perimenopausal and post-menopausal women in India.

2.Limited population-based studies were undertaken to correlate sun exposure and dietary intake of calcium(mg/day) in perimenopausal and postmenopausal women in different states of India.

3.This study will attempt to contribute in this area so that community-based interventions can be planned for this group of women.

### **3. RESEARCH METHODOLOGY:**

A multi-stage, stratified sampling design was used for the selection of the study population. A total of 1210 perimenopausal and postmenopausal women from Mumbai(n=400),

Hyderabad(n=410), and Bidar(n=400) constituted the study sample. This study was approved by Tanvir Hospital-Institutional Ethics committee for Biomedical and Health Research, Hyderabad. The project was also approved by the District Health Office of Bidar and the Municipal administration Department Government of Telangana state. Hyderabad District.

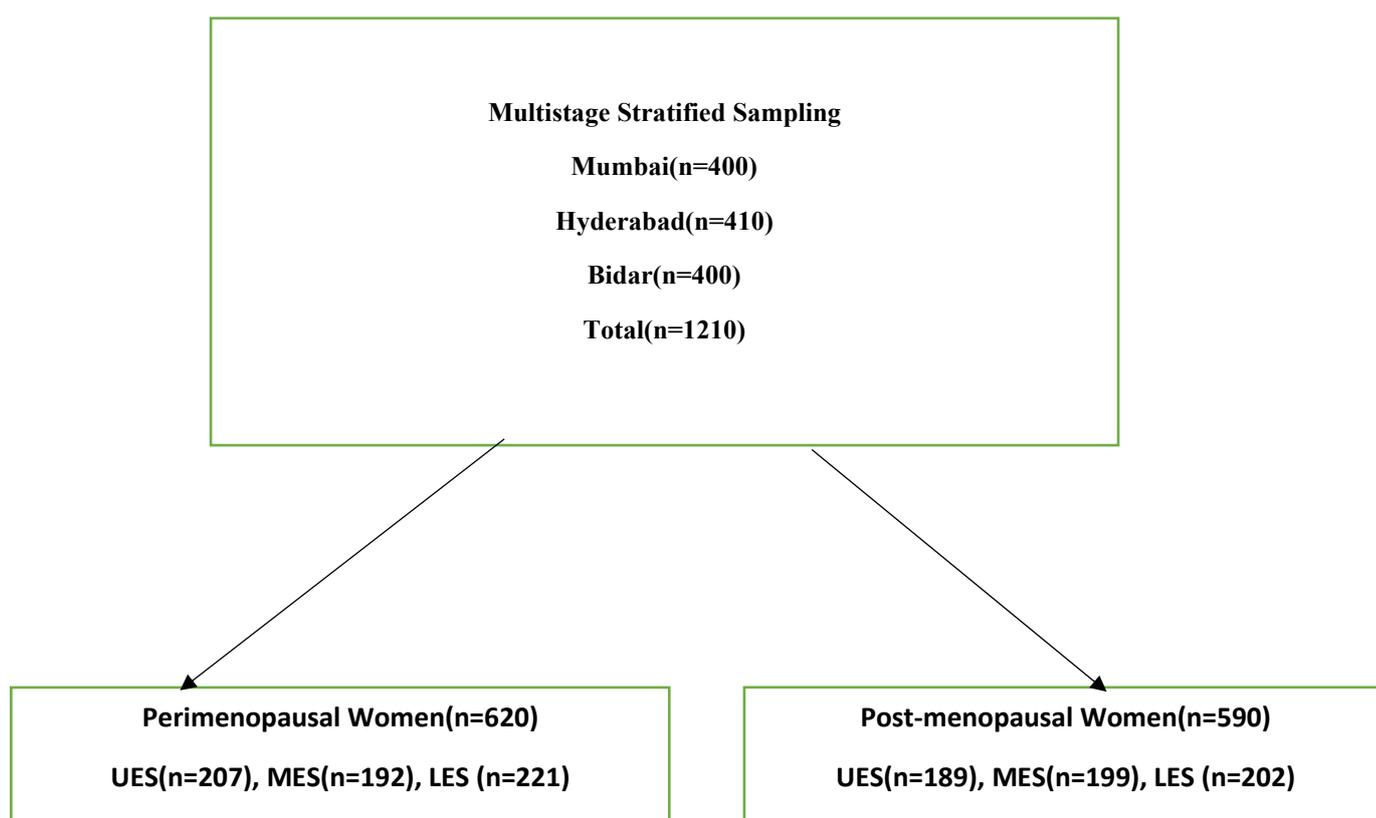
**Sampling Method**

A total of 1210 households were screened by multistage stratified sampling procedure.

**Stage 1:** The Ward/ Mandal / CD blocks of the city were selected by simple random sampling by from Mumbai, Hyderabad, and Bidar respectively.

**Stage 2:** The area was selected from ward/ Mandal /CD blocks by random sampling from Mumbai, Bidar, and Hyderabad respectively.

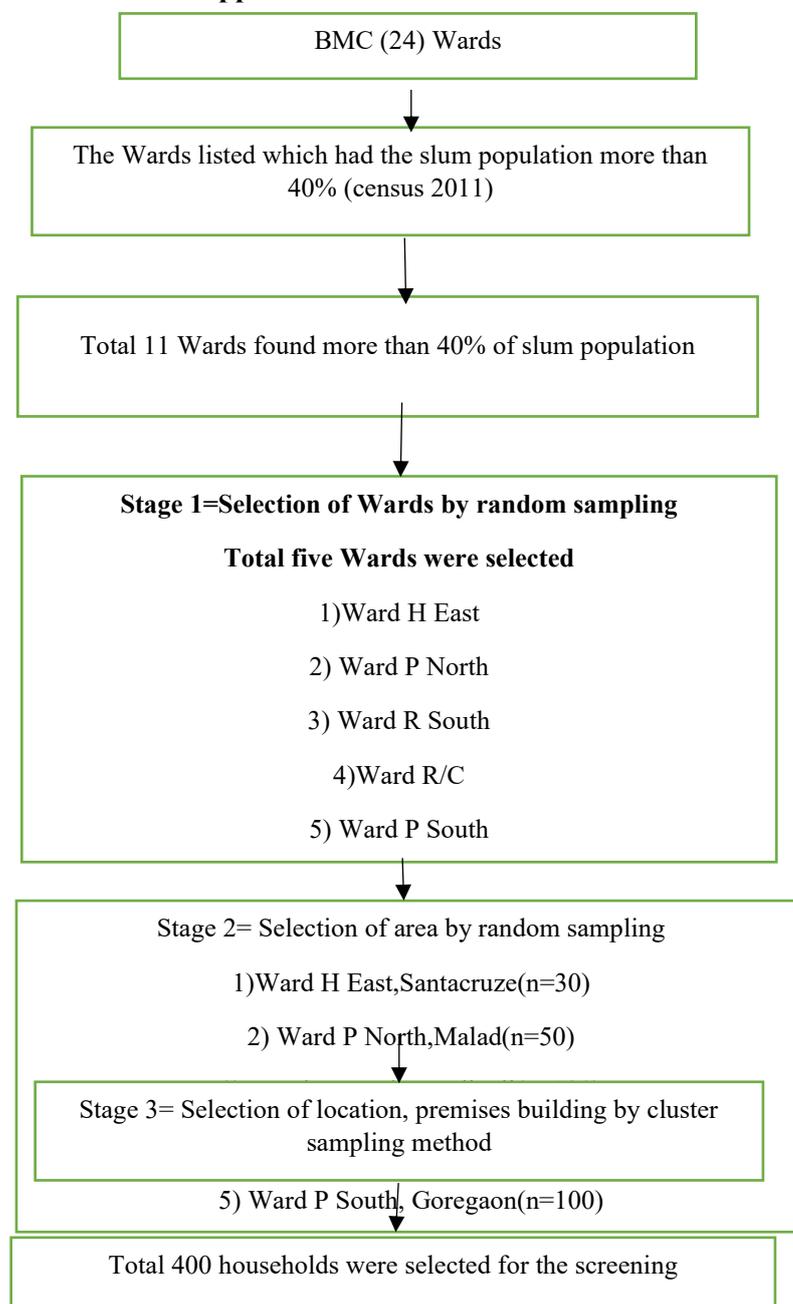
**Stage 3:** The location and premises of the city were selected with cluster sampling method



**Figure 1. Sampling Method of the total population studied**

{upper economic strata (UES), middle economic strata (MES) and lower Economic strata (LES)}.

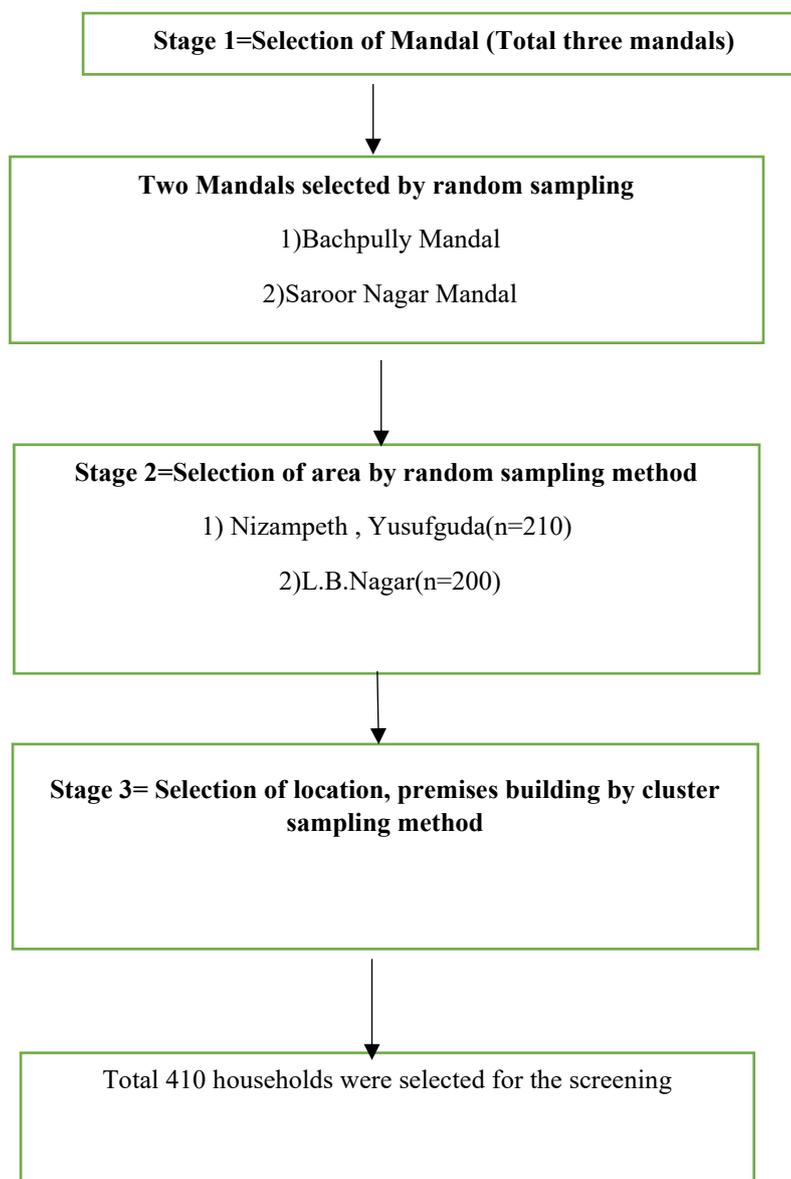
**The Sampling Method for Mumbai is appended below:**



**Figure 2. Sampling Method for Mumbai**

According to the eligibility criteria from each of the mentioned selected area wards, locations, and buildings about 200 perimenopausal women and 200 postmenopausal women were selected for the survey.

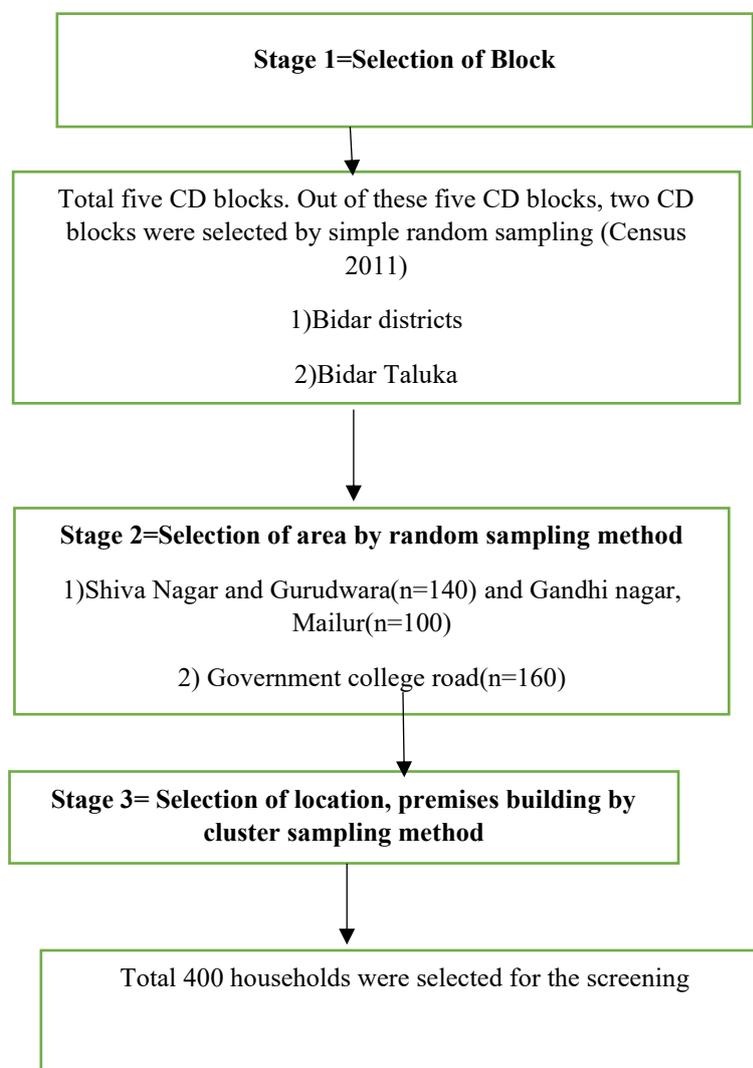
**The Sampling Method for Hyderabad is appended below:**



**Figure 3. Sampling Method for Hyderabad**

According to the eligibility criteria from each of the mentioned selected areas, locations, and buildings 210 perimenopausal women and 200 postmenopausal women were selected for the survey.

**The Sampling Method for Bidar is appended below:**



**Figure 4. Sampling Method for Bidar**

According to the eligibility criteria for each of the mentioned selected areas, locations, and buildings 214 perimenopausal women and 186 postmenopausal women were selected for the survey

#### **Inclusion Criteria for Perimenopausal Women**

Menstruating – regular or irregular-perimenopausal defined as their last menstrual period within the past year but not within the past 03 months.

Age group – 40 -61 years

#### **Exclusion criteria for perimenopausal**

Premature ovarian failure

Use of systemic hormonal preparations in the 03 months – Estrogens, Progesterone, Androgens (Androstenedione, DHEA), and Testosterone, Tibolone

Psychological disorders – Depression, Anxiety, Psychotic disorder hysterectomies women.

### **Inclusion Criteria for Post-Menopausal Women**

Women who have amenorrhea more than twelve months and attain menopause

Age group 40-61 years

### **Exclusion Criteria for Post-Menopausal Women**

Premature ovarian failure, post-menopausal bleeding

Use of systemic hormonal preparation in the 3 months - Oestrogen, Progesterone, Androgens, (Androstenedione, DHEA), and Testosterone, Tibolone, Hysterectomized women

### **Data collection**

All the participants of study population were explained the aims, objectives, and the details of the data collection. Consent was taken before data collection from the participants in English, Hindi, Marathi, Telugu, and Kannada language. The following research tools were used in the study. To validate tools, pilot study was conducted.

### **Research Tools:**

#### **1.Sunlight exposure questionnaire:**

A validated sunlight exposure questionnaire was used for gathering information of the participant's exposure to sun <sup>[17]</sup>. Participants were asked about the nature of the work/ job, and direct sunlight exposure in minutes per days between 7 AM to 11 AM, 11 AM to 3 PM, and 3 PM to 5 PM separately. Also, questions about the nature of woman's participants working pattern such as home-maker, working, table work, shop floor, fieldwork, agriculture, retirement, and other questions were asked in detailed. Women's activity such as outdoor and indoor was also asked. Solar radiation between 7 - 11 a.m. and 3-7 p.m. is 40% of radiation between 11 a.m. and 3 p.m. Therefore, estimated sunlight exposure duration between 8 and 11 a.m. and 3 and 5 p.m. from the questionnaires was converted to 40% and added to sunlight exposure duration between 11 a.m. and 3 p.m. Estimation of skin area percentage based on Lund and Browder chart as 5% (full sleeves+ cap), 10% (half sleeves+ cap) and 15% (half sleeves+ no cap).

#### **2.Semi-quantitative Food Frequency Questionnaire (SFFQ):**

Validated semiquantitative Food Frequency Questionnaire <sup>[12]</sup> was used to assess the calcium dietary intake of perimenopausal and postmenopausal women. This validated developed food frequency questionnaire comprised of all the food groups that are rich in calcium per 100gm as well as small, medium, and large portion sizes was provided to the participant. The questionnaire also helped to bring information on the serving size at one time and the frequency of intake of calcium-rich foods.

#### **3.Osteoporosis Self-Assessment Tool for Asians (OSTA):**

OSTA score is based simply on age and weight. The OSTA score was calculated by subtracting age from weight and multiplying by 0.2.  $OSTA = 0.2[\text{weight (kg)} - \text{age (year)}]$ . After getting scores, women were classified into high-risk, moderate-risk, or low-risk categories. The score was associated with the prevalence of osteoporosis in the future. The cut-offs and corresponding Osta-score range are High risk-20-4 Moderate risk-3-1 Low risk 1-20 <sup>[9]</sup>.

### **Statistical Analysis:**

All the collected data were statistically analysed by SPSS version 20. Descriptive data analysis was done by mean and SD. Correlation between the variables was made by using t test. A p - value less than 0.05 was considered significant.

**4.RESULTS AND DISCUSSION:**

**Demographic details of the study population:**

The demographic details of the study population from all study sites (Mumbai, Hyderabad, and Bidar) are given in Table 1.

**Table 1. Demographic details of the study population.**

Characteristic	Perimenopausal (n=620)			Postmenopausal (n=590)		
	Mumbai (n=200)	Hyderabad (n=206)	Bidar (n=214)	Mumbai (n=200)	Hyderabad (n=206)	Bidar (n=214)
<b>Age(years) Mean ±SD</b>	43.5±3.1	43.6±4.4	42.4±4.3	55.4±4.8	51.7±6.0	52.4±4.3
<b>Age of menopause Mean ±SD</b>	-	-	-	46.1 ±8.0	45.2 ±6.0	44.9 ±5.4
<b>Marital Status</b>						
Married n (%)	186(93%)	196(95.1%)	206(95.8%)	191(95.5%)	154(75.5%)	174(93.5%)
<b>Parity</b>						
Two children, n (%)	78(39%)	117(56.8%)	115(53.5%)	154(77%)	100(49.9%)	51(27.4%)
Three children n (%)	28(14%)	50(24.3%)	14(18.6%)	9(4.5%)	44(21.1%)	80(43%)
<b>Religion</b>						
Hindu, n (%)	171(85.5%)	190(92.2%)	107(49.8%)	196(98%)	199(97.5%)	109(58.6%)
Muslim, n (%)	22(11%)	4(1.9%)	15(7.0%)	1(0.5%)	4(2%)	7(3.8%)
Sikh, n (%)	2(1.0%)	9(4.4%)	39(18.1%)	2(1.0%)	1(0.5%)	21(11.3%)
<b>Dietary Pattern</b>						
Vegetarian, n (%)	143(71.5%)	26(12.6%)	83(38.6%)	130(65.5%)	12(5.9%)	50(21.3%)
Non-vegetarian n (%)	57(28.5%)	180(87.4%)	132(61.4%)	67(33.5%)	192(94.1%)	136(78.7%)
<b>Type of family</b>						
Nuclear family, n (%)	146(73.3%)	205(99.5%)	210(97.7%)	182(91%)	200(99.6%)	183(98.4%)
Joint family, n (%)	52(26%)	1(0.5%)	2(1.2%)	18((9%)	6(0.4%)	2(1.1%)
<b>Total annual income</b>						
39,033–78,062 n (%)	100(50.5%)	65(31.6%)	66(30.7%)	66(33%)	60(29.4%)	36(19.4%)
29,200 –39,032 n (%)	21(10.5%)	-	40(18.6%)	66(33%)	63(30.9%)	37(19.9%)
19,516–29,199 n (%)	44(22%)	-	10(4.7%)	4(2%)	-	9(4.8%)
11,708–19,515n (%)	5(2.5%)	81(39.9%)	27(12.6%)	44(22%)	-	47(25.3%)
3,908–11,707 n (%)						

	8(4.0%)	-	22(10.2%)	7(3.5%)	81(39.7%)	7(3.8%)
<b>Nature of work</b>						
Homemaker, n (%)	110(55%)	81(39.3%)	17(7.9%)	70(30.5%)	114(55.9%)	27(7.9%)
Working, n (%)	86(43%)	125(60.7%)	193(89.8%)	130(65%)	89(43.6%)	160(92.8%)

Among the women studied, the average age at menopause in post-menopausal women was 46.1 ±8.0, 45.2 ±6.0, and 44.9 ±5.4 in Mumbai, Hyderabad, and Bidar, respectively. The majority of participants from Hyderabad (perimenopausal =87.4%, post-menopausal=94.1%) and three-fourth of the participants from Bidar (perimenopausal =61.4%, post-menopausal=78.7%) were non-vegetarian, whereas only one-third of the participants from Mumbai (perimenopausal =28.5%, post-menopausal=33.5%) were non-vegetarian. For the nature of work-related perceptions, the majority of participants from Bidar (perimenopausal =89.8%, post-menopausal=92.8%) were working.

**Sunlight exposure in perimenopausal, and postmenopausal women in the population surveyed:**

Sunlight exposure in perimenopausal, and post-menopausal women was evaluated with the help of validated sunlight exposure questionnaire<sup>[17]</sup>.

**Table 2. Percent population getting exposure to sunlight in Mumbai, Hyderabad, and Bidar**

Sunlight exposure remark	Mumbai (n=200) n (%) [perimenopausal]	Mumbai (n=200) n (%) [post-menopausal]	Hyderabad (n=206) n (%) [perimenopausal]	Hyderabad (n=204) n (%) [post-menopausal]	Bidar (n=214) n (%) [perimenopausal]	Bidar (n=184) n (%) [post-menopausal]
<b>Less than fifteen minutes/day (High Risk)</b>	168 (84%)	176(88%)	126 (61.2%)	132 (64.7%)	199 (92.6%)	180 (96.8%)

Majority of perimenopausal women from [Mumbai (84%), Hyderabad (61.2%), Bidar (92.6%)] and the post-menopausal women from [Mumbai (88%), Hyderabad (64.7%), Bidar (96.8 %)] had sun exposure less than fifteen minutes per day which is a major risk factor for vitamin D deficiency. This deficiency, in turn, contributes to an increased risk of osteoporosis and weakened bone health in the studied population.

In our study, perimenopausal and postmenopausal women exhibited low levels of sunlight exposure, primarily due to their household work and increased time spent indoors. In line with our finding, the study conducted<sup>[3]</sup> in Delhi during August–September month observed relationship between varying durations of sun exposure and vitamin D status in males. They concluded that outdoor workers with prolonged sun exposure tend to have higher levels of serum 25(OH)D and bioavailable 25(OH)D. This supports the role of sun exposure in maintaining adequate vitamin D levels.

The association between sunlight exposure, vitamin D levels, and bone health is well-documented. Sunlight exposure plays a key role in vitamin D synthesis, which in turn is essential for maintaining bone health and preventing osteoporosis. A study conducted<sup>[8]</sup> among 186 women in Iran (Sirjan Gol

Gohar Company staff) found that increased sun exposure was associated with better spine BMD and lower likelihood of low BMD diagnosis. They concluded a significant protective association between spine BMD ( $p$ -value = 0.023), indicating that individuals with more sun exposure had a lower likelihood of being diagnosed with low BMD. The BMD diagnosis ( $p$ -value = 0.036) and sun exposure suggests that increased sun exposure is associated with better spine BMD. Some studies explore association between period of sunlight and serum 25(OH) D levels. In align with this context, research in West Bengal among 236 rural women aged 60-70 highlighted a positive correlation between sun exposure and serum 25(OH)D levels, supporting bone health<sup>[2]</sup>. They concluded that sun exposure index was low sufficient to deficient Vitamin D status group.

Our research has highlighted vitamin D insufficiency as an important risk factor for osteoporosis and fractures. Both perimenopausal and postmenopausal women with low sunlight exposure are at higher risk for osteoporosis.

Further, the osteoporosis risk with the help of OSTA score was calculated. The Osteoporosis Self-Assessment Tool for Asians (OSTA) was first developed as a simplified method to assess the risk of osteoporosis in Asian populations in 2001<sup>[9]</sup>. The association between OSTA score and sunlight exposure was investigated with the help of t test.

### **Association of OSTA score distribution, and sunlight exposure in perimenopausal and postmenopausal women.**

The OSTA score and sunlight exposure were compared and a statistically significant difference was observed between perimenopausal and post-menopausal women [Mumbai( $t=3.788$ ,  $p=0.000$ ) Hyderabad ( $t=-4.193$ ,  $p=0.000$ ) and Bidar( $t=-7.778$ ,  $p=0.000$ )]. This observation revealed that majority of the women from Mumbai Hyderabad and Bidar had sun exposure less than fifteen minutes per day and between perimenopausal and postmenopausal women, it was post-menopausal women who had sunlight exposure less than fifteen minutes per day and at high risk of osteoporosis .

### **Semi-quantitative Food Frequency Questionnaire (SFFQ):**

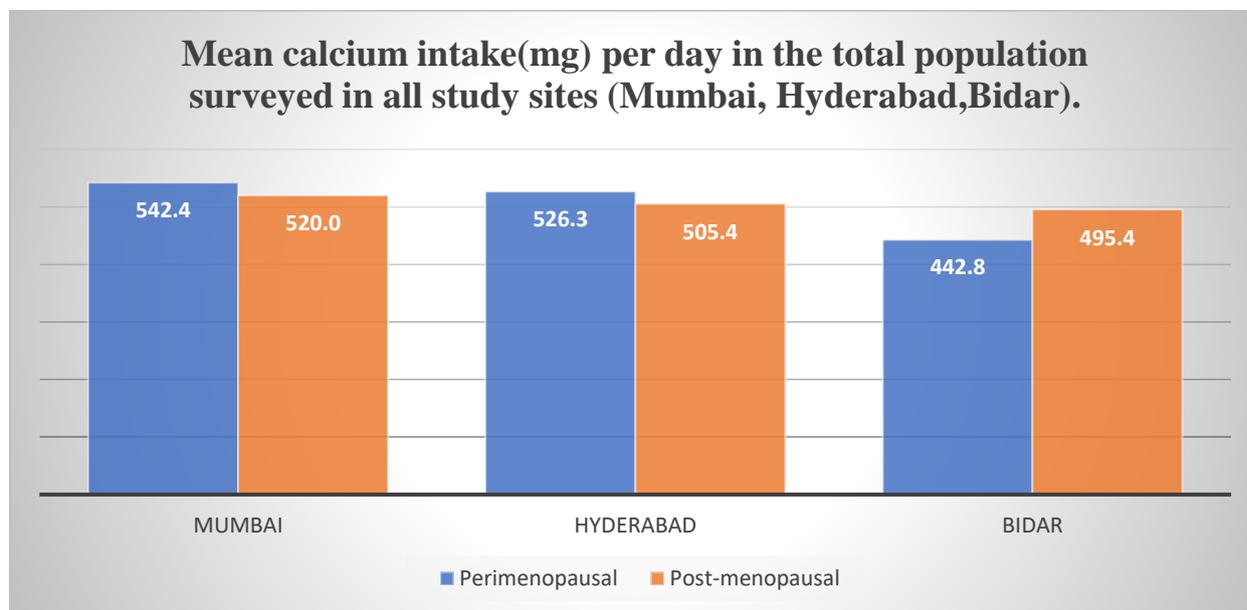
The mean dietary calcium intake(mg/day) of subjects in both the groups was found to be grossly deficient (Mumbai (542.4±221.), Hyderabad (526.3±169.7) and Bidar (442.8±124.9) for perimenopausal women and (Mumbai (520.0±141.6), Hyderabad (505.4 ±129.8) and Bidar (495.4±169.4) for postmenopausal women. The calcium intake was inadequate for both groups, for perimenopausal (Mumbai- 68.4%, Hyderabad-65.7%, Bidar-55.3%) of EAR and (Mumbai- 54.7%, Hyderabad-52.6%, Bidar-44.2%) of RDA and postmenopausal (Mumbai-52%, Hyderabad-48.4%, Bidar-49.5%) of EAR and (Mumbai- 43.3%, Hyderabad-40.3%, Bidar-41.2%) of RDA. This was in align with similar studies<sup>[1]</sup> where the calcium intake of subjects in both the groups was found to be grossly deficient (534.31±183.7 and 421.62 ±164.9) for perimenopausal and postmenopausal subjects respectively and meeting only 50-60% of the requirement. Another similar finding was observed in a study<sup>[7]</sup> in Tamil Nadu, India on 106 postmenopausal women, the findings suggested that the average dietary calcium intake (DCI) of 632.72 ± 28.23 mg/day was below the RDA for calcium, with 74.5% of postmenopausal women having dietary deficiency of calcium and majority of the postmenopausal women were physically inactive. This supports the need for increased education regarding dietary calcium intake during the perimenopausal and postmenopausal period to prevent morbidity and mortality associated with osteoporosis and other disorders associated with calcium deficiency.

The majority of women (perimenopausal and postmenopausal) studied, both in our study and in similar studies conducted in India, had a poor intake of calcium in their diet and are therefore, at an increased risk for osteoporosis and fracture.

Our research has highlighted vitamin D insufficiency as an important risk factor for osteoporosis and fractures. Both perimenopausal and postmenopausal women with low sunlight exposure are at higher risk for osteoporosis. In the context of this, association between dietary calcium intake(mg/day) and sunlight exposure was investigated.

**Association of dietary calcium intake(mg/day), and sunlight exposure in perimenopausal and postmenopausal women in Mumbai, Hyderabad, and Bidar.**

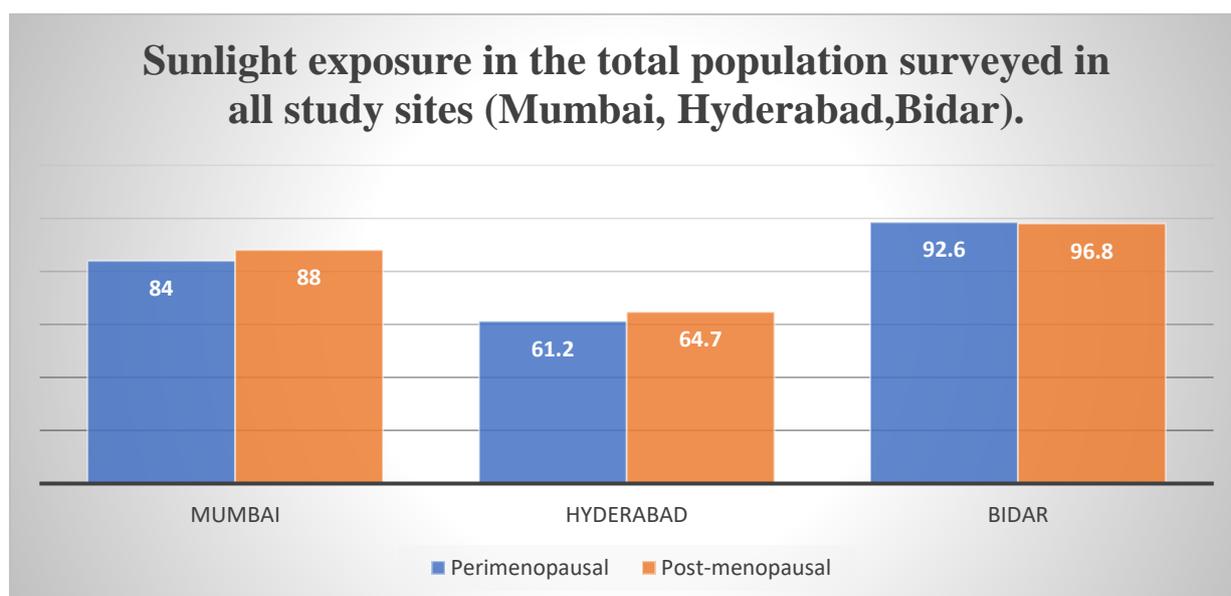
The association between the mean dietary calcium intake(mg/day) and sunlight exposure was investigated to know the osteoporosis risk in the population surveyed



**Fig 5. The mean dietary calcium intake(mg/day) in perimenopausal and postmenopausal women in Mumbai, Hyderabad, and Bidar.**

The mean dietary calcium intake(mg/day) in perimenopausal and postmenopausal women was found to be grossly deficient and not meeting EAR and RDA.

**The sunlight exposure in the total population surveyed in all study sites (Mumbai, Hyderabad, Bidar).**



**Fig 6. The sunlight exposure in the total population surveyed in all study sites (Mumbai, Hyderabad, Bidar).**

In our study, the association between mean dietary calcium intake(mg/day) and sunlight exposure was investigated. The mean dietary calcium intake was inadequate for both groups, for perimenopausal (Mumbai- 68.4%, Hyderabad-65.7%, Bidar-55.3%) of EAR and (Mumbai- 54.7%, Hyderabad-52.6%, Bidar-44.2%) of RDA and postmenopausal (Mumbai-52%, Hyderabad-48.4%, Bidar-49.5%) of EAR and (Mumbai- 43.3%, Hyderabad-40.3%, Bidar-41.2%) of RDA .Majority of perimenopausal and postmenopausal women had inadequate sunlight exposure ( less than fifteen minutes per day).The findings of our study highlighted that both the group are at risk of osteoporosis as well as weak bone health due to low dietary calcium intake and low sunlight exposure. The combination of low dietary calcium intake and low sun exposure has a mingled effect on osteoporosis risk. Limited studies have shown association between poor dietary calcium intake and low sunlight exposure, the two major risk determinants for osteoporosis and fracture, especially in postmenopausal women. Our study findings were supported by a study <sup>[10]</sup> conducted to evaluate the diet with particular emphasis on calcium and vitamin D intake and sun exposure in perimenopausal women aged 45-55 years from Warsaw in terms of risk of osteoporosis. They concluded inadequate intake of calcium and vitamin D among the majority of perimenopausal women. Further, they also concluded that the highest percentage of women represented attitudes towards prevention of osteoporosis, characterized by insufficient exposure to sunlight and a diet deficient in both calcium and vitamin D.

Adequate exposure to the sun as the main non-nutrition source of vitamin D is essential to achieving peak bone mass, and as the main factor in the prevention of osteoporosis. Encouraging individuals to adopt a balanced diet rich in calcium and vitamin D, engage in regular physical activity, and get adequate sunlight exposure can help support optimal bone health throughout life.

## **5. CONCLUSION:**

Exposure to sunlight is an effective way to obtain vitamin D and is essential for maintaining bone health along with dietary calcium intake. The study reveals that a significant proportion of perimenopausal and postmenopausal women have limited sunlight exposure, averaging less than fifteen minutes per day. This limited sunlight exposure likely contributes to a higher prevalence of vitamin D deficiency among these women, which is a key risk factor for osteoporosis. The study indicates that insufficient sunlight exposure is prevalent more among postmenopausal women, leading to potential vitamin D deficiency. This deficiency is exacerbated by household work and increased indoor activities, which further limit sun exposure. The study also highlights inadequate dietary calcium intake in perimenopausal and post-menopausal women in different states in India. To address this, it is essential to encourage dietary changes that include foods rich in calcium. These include both dairy products as well as non-dairy products (ragi, amaranth flour, sesame seeds, horse gram, cluster beans etc.). By addressing both sunlight exposure and dietary intake, effective strategies can be developed to combat vitamin D deficiency and calcium insufficiency, potentially improving bone health and reducing the risk of osteoporosis.

We conclude, an important element of the prevention of diseases of the skeletal system is provided by nutritional education, primarily by incorporating calcium rich food and modification of women's behaviour toward a healthy lifestyle includes sunlight exposure.

## **6. LIMITATION:**

This research was done without therapeutic measures.

## **7. RECOMMENDATIONS:**

This kind of population-based research with the help of therapeutic measures across PAN India is recommended.

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