AJHS
Asian Journal of Home Science
Volume 10 | Issue 2 | December, 2015 | 342-352

DOI: 10.15740/HAS/AJHS/10.2/342-352
e ISSN-0976-8351 ■ Visit us: *www.researchjournal.co.in*

Research Paper

Bone mineral density and nutritional status of postmenopausal women

■ KUSUM LATA **AND** SUKHNEET SURI

Received: 30.06.2015; **Revised:** 23.10.2015; **Accepted:** 01.11.2015

■ **ABSTRACT :** The study was carried out to assess the nutrient intake and to identify errors in dietary habits of postmenopausal women with special relevance to bone health. Another purpose of the study was to assess their lifestyle habits including physical activity and sun- exposure. Thirty seven women aged 45 to 60 years were enrolled according to the inclusion and exclusion criteria stated in the study. Data analysis revealed that as per World Health Organization standards 75.68 per cent (28) women had normal BMD, 18.92 per cent (7) had osteopenia and 5.41 per cent (2) women were suffering from osteoporosis. Intake of energy, protein, visible fat, invisible fat, calcium, phosphorus, iron, magnesium, vitamin A, vitamin D, vitamin E, vitamin K were below the RDA (India) in the diets of about 59.46 per cent (22), 37.84 per cent (14), 29.73 per cent (11), 5.41 per cent (2), 16.22 per cent (6), 0 per cent, 59.46 per cent (22), 18.92 per cent (7), 100 per cent (37), 86.49 per cent (32), 75.68 per cent (28), 2.70 per cent (1) women, respectively.59.46 per cent (22) women were taking nutrient supplements *i.e.* calcium, vitamin D and multivitamins. 16.22 per cent (6) women had deficient calcium status; they were consuming significantly low dietary calcium and were not taking calcium supplements. It was found that, except 36.36 per cent (8) women (those taking Vitamin D supplements); all were deficient in vitamin D. Several reasons/ causes for lower physical activity or disinterest in regular exercise were identified. 29.73 per cent (11) postmenopausal women experienced discomfort while walking. Sub-optimal nutritional status could be one of the major contributory factor of poor bone health. In the absence of balanced diet and sun exposure, nutrient supplements become necessary to support bone health of postmenopausal women.

■ **KEY WORDS:** Bone mineral density, Osteoporosis, Postmenopausal women, Serum vitamin D, Anthropometric measurements

■ **HOW TO CITE THIS PAPER :** Lata, Kusum and Suri, Sukhneet (2015). Bone mineral density and nutritional status of postmenopausal women. *Asian J. Home Sci.*, **10** (2) : 342-352.

See end of the paper for authors' affiliations

LATA KUSUM
Department of Dietetics, Brahm Shakti Hospital, DELHI, INDIA
Email : kusum.delhi@gmail.com

Osteoporosis, with its consequences of fragile bones and fracture (s), is increasingly becoming a public health problem in industrialized and developing countries. According to the WHO (2007) criteria, osteoporosis is defined as a Bone Mineral Density (BMD) that lies 2.5 standard deviations or more below the average value for young healthy women (a T-score of <-2.5 SD). Low BMD is a major factor for osteoporosis related fractures (Anderson *et al.*, 2010). Women lose about 5 per cent of their trabecular bone

and 30 per cent of their cortical bone during menopause (Finkelstein *et al.*, 2008). These contribute to the higher incidence of osteoporosis in females. Women have greater bone loss than men, especially after the onset of menopause due to hormonal changes and reduced absorption efficiency of calcium. Average menopausal age in Indian women is 46.3 years as compared to 51 years in western countries (Salve *et al.*, 2010). This physiological transition is characterized by depletion of the ovarian follicles, decreasing estradiol and inhibin (regulates FSH synthesis and inhibits FSH secretion) production, leading to an increase in follicle- stimulating hormone (FSH), loss of menstrual cycles, accompanied by menopausal symptoms (Chattha *et al.*, 2008). After natural and surgical menopause, women suffer from major symptoms of estrogen deficiency, which affects their quality of life (Battacharya and Jha, 2010). Added to the non- modifiable factors such as age, sex and menopause, several modifiable factors also affect osteoporosis such as sedentary lifestyle, prolonged low calcium intake, vitamin D deficiency, multiple nutrient deficiencies to name a few.

Among the many factors that affect BMD, nutrition is considered to be of great significance. Many of the nutrients and food components have positive or negative impact on bone health (Heaney and Recker, 1982). These dietary factors range from minerals (e.g. calcium, phosphorus, magnesium, sodium, potassium and various trace elements) and vitamins (vitamins A, D, E, K, C and certain B vitamins) to macronutrients, such as protein and fatty acids (Cashman, 2007).Several vitamins play significant roles in maintaining bone health. Vitamin A is required for the activity of osteoblasts during remodeling of bone. Vitamin C is essential for synthesis of collagen; a major bone protein. Vitamin K, E and B_{12} are also needed for the synthesis of bone proteins (Tortor and Derrickson, 2009). Synthesis of the intracellular calcium- binding protein required for calcium absorption is induced by vitamin D. This vitamin also affects the permeability of the mucosal cells to calcium, an effect that is rapid and independent of protein synthesis. Vitamin D is found naturally in very few foods; endogenous synthesis of vitamin D, therefore, which occurs when skin is exposed to Ultra Violet (UV) radiations from sunlight; is a principal determinant of vitamin D status (McCarty, 2008).Dietary fatty acids have been found to influence bone health variably. An increasing ratio of total dietary n-6 to n-3 fatty acids has been found to be significantly and independently associated with lower BMD at the hip (irrespective of using or not using hormone therapy) and at the spine in women not using hormone therapy (Weiss *et al.*, 2005). In yet another study by Järvinen *et al.* (2012) beneficial effects of consuming dietary PUFAs has been observed in improving bone mineral density at lumbar spine and in total body but not at femoral neck. According to Orchard *et al.* (2012), the beneficial effect of n-3 fatty acids on skeletal health can be maximized if combined with concurrent administration of calcium.

Food components such as lignans and isoflavones have been found to positively influence bone health.In a study carried out by Simbalista *et al.* (2010), the effect of incorporating breads containing 25g flaxseeds (46mg lignans-control group) or wheat bran (<1mg lignans-placebo group) everyday for 12 weeks on the frequency of hot flashes, Kupperman Menopausal Index and endometrial thickness was compared. Both the groups showed significant reduction in the frequency of hot flashes and Kupperman Menopausal Index but no significant difference was observed in the symptoms between both the groups. Several studies have found that soy isoflavones are useful in reducing the severity and frequency of vasomotor changes in peri and post menopausal women (Nahla Elbostany *et al.*, 2013; Burke *et al.*, 2003; Knight *et al.*, 2001 and St. Germain *et al.*, 2001). Another study by Brooks *et al.* (2004) showed that dietary supplementation with 25 g ground flaxseed but not with 25 g soy flour significantly alters the metabolism of estradiol in favour of the less biologically active estrogen metabolite in postmenopausal women. Further, flaxseed has been found to improve the lipid profile of dyslipidemics without altering the biomarkers of bone metabolism in post-menopausal women (Lucas *et al.*, 2002).

Physical activity has been shown to contribute to bone mass and strength during the postmenopausal years (Rikkonen *et al.*, 2010). Physical activity both aerobic as well as resistance training have shown to increase the peak bone mass which is attained during adulthood and attenuate the rate of loss in the postmenopausal years (Maria and Singh, 2000).According to a study conducted by Aggarwal *et al.* (2011), 46.8 per cent women with low BMD as compared to 33 per cent women with normal BMD (during the peri- and post-menopausal

phase) were leading a lifestyle with low physical activity.

Osteoporosis, a silent progressive metabolic bone disorder, is expected to have crossed the 36 million prevalence level in India. ICMR had recognized in 2009 that with increasing longevity of the Indian population, osteoporotic fractures (as in the west) would be a major cause of morbidity and mortality in the postmenopausal as well as elderly in the near future. The medical and economic implications of osteoporosis are massive especially for developing countries and it is therefore imperative to identify the prevalent dietary and lifestyle related errors, facilitate early screening and create awareness among the masses for the prevention and correct treatment of osteoporosis especially for the most vulnerable target group *i.e.* postmenopausal women. The study was therefore done to assess the impact of changing lifestyle, dietary habits and medical interventions on the bone mineral density and overall nutritional status of postmenopausal women.

The study was therefore conducted with the following objectives in mind: 1. To study the association of clinical and health parameters with nutritional status with respect to osteoporosis and identify errors in dietary habits associated with compromised bone health, 2. To study the life style habits including physical activity and sun- exposure of postmenopausal women and 3. To gather data on anthropometric measurements (height, weight, hip and waist circumference), clinical (blood pressure, ultrasonography report and DXA) and biochemical parameters (hemoglobin, serum calcium, vitamin D).

■ RESEARCH METHODS

Thirty Seven (37) postmenopausal women in the age group of 45 to 60 years were enrolled randomly from the Outdoor Patient Department (Gynecology) at Sitaram Bhartia Institute of Science and Research in New Delhi during April 2013 to April 2014 (after obtaining necessary permission from the authorities). Patients were enrolled on the basis of patient inclusion-exclusion criteria. Informed written consent was obtained from each woman before enrolling. The following tools and techniques were used for the necessary data collection:

– Consent form (along with information sheet).

– Anthropometric measurements *i.e.* height, weight, waist and hip circumference for computing Body Mass Index (BMI) and Waist Hip Ratio (WHR), respectively.

– Clinical parameters *i.e.* blood pressure and Bone Mineral Density (through Dual Energy X- ray Absorptiometry).

– Biochemical parameters *i.e.* hemoglobin, serum calcium, 1,25dihydroxy vitamin D (fasting blood sample).

– Questionnaires to gather data on general information, dietary habits, physical activity, medical history and clinical profile.

– Performa(s) for recording 24hrs dietary recall intake, and 24 hour physical activities.

– Food frequency checklist for gathering information on the food choices.

– Standardized serving utensils such as cups (size A, B, C, D), glasses (small, medium, large), spoons and cutouts such as small medium and large chapattis for gathering dietary intake data.

Data were gathered by the help of above mentioned tools and techniques (during four sessions of follow-ups through personal contact) on personal profile, socio-economic status, dietary habits/intake, anthropometric measurements, clinical profile, medical history, family history, physical activity pattern and lifestyle habits.

■ RESEARCH FINDINGS AND DISCUSSION

Women enrolled in the study belonged to the age group of 45 to ≤ 60 years. Their average age at menopause was 47.24 ± 3.41years (34-53 years). The average age of subject's mother and the siblings at the time of their menopause was 48.05 ± 4.52years (42.5-60.0years) and 47.03 ± 2.59 years (41- 51 years), respectively. Details about the reproductive history (*i.e.* conception, successful pregnancies, miscarriages and abortions) indicated that majority had normal reproductive health during their young adulthood years (Table 1). Repeated pregnancies and closed spaced pregnancies were not a major contributory factor to result in poor bone health among the enrolled group.

The mean body mass index (BMI) of women belonging to normal, pre-obese, class I and class II categories was 21.59±0.89 (20.25- 22.26), 23.89±0.43 (23.51-24.39), 27.03± 1.53 (25.2- 29.78), 32.46± 2.11 (30.1-35.52), respectively indicating that majority *i.e.* 75.68 per cent women were overweight or obese (Table 2). None were having a low BMI. Thus, low BMI, which has been found to be associated with low BMD

(Aggarwal *et al.*, 2011) was not a risk factor for compromised bone health in the enrolled group.

Obesity of the lower abdomen is a risk factor for early menopause, impaired blood circulation in the legs and resultant poor muscle as well as bone health, which results in compromised body movement and physical activity. Abdominal obesity refers to waist–hip ratio (WHR) above 0.85 for females which corresponds to a body mass index (BMI) above 30.0 kg/ m^2. There was predominance of abdominal obesity (64.86 %) in the enrolled group (Table 2).

The dietary habits and dietary intake was studied in detail to identify dietary factors influencing the nutritional status of postmenopausal women. Regarding meal pattern, majority *i.e.* 86.49 per cent (32) women were not eating in between their meals. Only 8.11 per cent (3) women had the habit of nibbling in between meals and most (64.86 %; 24) were not binging at all. Approximately 27.03 per cent (10) women used to eat snacks occasionally while 8.11 per cent (3) women were frequent consumers of snacks, usually with evening tea. The snacks consumed however were not nutritious; the commonly consumed snacks being *bread pakora, samosa, khasta kachori, pizza, biscuits* and fried packaged / other snacks. It was found that shortage of time and/or preference for a sedentary lifestyle contributed to the increased use of processed food. There was preference for the consumption of convenience foods, ready to eat foods, ready to cook foods and other packaged foods by majority *i.e.* 99.99 per cent, 96.13per cent, 90.00 per cent and 8.11per cent women, respectively.

Data on food choices indicated that 51.35 per cent (19) women were consuming fruits without edible peels while 48.65 per cent (18) women were consuming them with edible peels. Vegetables (as salads) without edible

Table 1 : Reproductive history

	Conception	Miscarriage	Abortion	Successful pregnancy	Hysterectomy
Frequency (Mean ± SD) (range)	3.305±1.68	1.666±0.59	1.857±1.43	1.371±1.04	-
	(0-9)	(0-2)	(0-7)	(0-6)	
Percentage (n)	97.3%	16.22%	56.76%	94.59%	21.62%
	(n=36)	(n=6)	(n=21)	(n=35)	(n= 8)

Table 2 : Body mass index and waist hip ratio according to WHO Asian Pacific perspective 2010

Anthropometric measurement	Body mass index (n= 37)				Waist hip ratio (n= 37)	
	Normal range	Pre- obese	Obese class I	Obese class II	>0.85	<0.85
Mean ± SD	21.59±0.89 (20.25-	23.89±0.43 (23.51-	27.03±1.53 (25.2-	32.46±2.11 (30.10-	0.88±0.44	0.81±0.034
(range)	22.26)	24.39)	29.78)	35.52)	(0.85-1.01)	(0.72- 0.84)
Percentage (n)	13.51%	10.81%	48.65%	27.03%	64.86%	35.14%
	(n=5)	(n=4)	(n=18)	(n=10)	(n=24)	(n=13)

Table 3 : Consumption of fruits and vegetables (Salads)

Fruits	Percentage (n)	Vegetables (salad)	Percentage (n)
With peel	48.65% (n=18)	With peel	45.95% (n=17)
Without peel	51.35% (n=19)	Without peel	54.05% (n= 20)

Note: bracket () gives information on number of subjects.

Table 4 : Frequency of consumption- fruits and vegetables (Salads)

Fruits		Vegetables (Salad)	
Everyday	83.78% (n=31)	Everyday	78.38% (n=29)
Alternate day	10.81% (n=4)	Alternate day	10.81% (n=4)
Weekly	05.41% (n=2)	Weekly	05.41% (n=2)
Fortnightly	-	Fortnightly	02.70% (n=1)
Monthly	-	Monthly	02.70% (n=1)
Occasionally	-	Occasionally	-

Note: bracket () gives information on number of subjects

peel and with edible peel were being consumed by 54.05 per cent (20) and 45.95 per cent (17), respectively (Table 3 and 4). The average daily fibre consumption of enrolled women was very low *i.e.* 8.39 ± 7.79g (3.51- 52.05).

Data revealed that maximum *i.e.* 91.89 per cent (34) women did not avoid the consumption of any particular food (s) during their menstrual cycle(s) prior to menopause. 5.41 per cent (2) women avoided consuming curd/ lassi, and only 2.70 per cent (1) woman avoided consumption of so called 'hot food' during their menstrual cycles (*i.e.* prior to menopause). Choice of calcium, phosphorus, vitamin D and other micronutrient rich foods such as milk and milk products was assessed and is given in Table 5 below.

Maximum 97.29 per cent (36) women used to consume whole pulses (rich in calcium as well as phosphorus) on alternate day which is a good dietary habit. Frequency of consumption of carbonated beverages was monthly, fortnightly, alternate days and everyday by 64.86 per cent (24), 21.63 per cent (8), 5.41 per cent (2) and 2.70 per cent (1) cases, respectively. Research indicates that regular consumption of carbonated beverages can affect bone health. Among frequent consumers of carbonated beverage, one woman each, were suffering from osteopenia and osteoporosis.

The dietary intake data obtained from 24 hour recall method was computed for obtaining the nutrient intake data which was subsequently compared with the Recommended Dietary Allowance (RDA)given by the Indian Council Medical Research (2010). The nutrient

Table 5 : Consumption of milk, milk products and milk based commonly consumed dishes

Milk and its products		Mean amount (g/ml)			
		Everyday	Alternate day	Weekly	Occasionally
Milk	(n=27)	239.58	100.00	212.50	-
Curd	(n=23)	120.14	109.38	-	-
Lassi	(n=11)	82.14	77.09	66.67	-
Paneer	(n=33)	62.5	44.69	51.06	52.42
Khoya	(n= 1)	-	-	10	-
Tea	(n=32)	62.39	25	-	-
Coffee	(n=8)	44.09	25	-	-
Milk based sweet dish	(n=5)	125	-	78.13	81.25
Ice- creams	(n=10)	70.71	65.78	68.25	96.43
Probiotics	(n=4)	65	100	50	-

Note: bracket () gives information on number of subjects.

Table 6 : Mean nutrient intakes and adequacy of recommended dietary allowance

Nutrients	Mean ±SD (Range)	<66%	66- 100%	>100%
Energy (kcal)	1250.24±350.38 (679.95-2151.77)	05.41% (n=2)	35.14% (n=13)	59.46% (n=22)
Visible fat (g)	17.26±6.94 (5-32.5)	29.73% (n=11)	40.54% (n=15)	29.73% (n=11)
Invisible fat (g)	15.09±7.61 (4.29-40.34)	*	*	*
Protein (g)	42.25±13.21 (19.7-67.41)	37.84% (n=14)	43.24% (n=16)	18.92% (n=7)
Crude fibre (g)	8.39±7.79 (3.51-52.05)	100%	00.00%	00.00%
Calcium (mg)	654.07±323.57 (272.2-1678)	16.22% (n=6)	35.14% (n=13)	48.65% (n=18)
Phosphorus (mg)	987.12±283.56 (531.75-1647.05)	00.00% (n=0)	02.70% (n=1)	97.29% (n=36)
Iron (mg)	29.38±68.91 (8.55-397.52)	59.46% (n=22)	24.32% (n=9)	16.22% (n=6)
Magnesium (mg)	339.52±176.26 (112.24-970.2)	18.92% (n=7)	27.03% (n=10)	54.05% (n=20)
Vitamin D (mcg)	0.18±0.30 (0-1.53)	86.49% (n=32)	08.11% (n=3)	05.41% (n=2)
Vitamin A (µg)	420.48±564.89 (58.18-2213.99)	100% (n=37)	00.00% (n=0)	00.00% (n=0)
Vitamin K (mg)	125.14±111.38 (35.65-481.3)	02.70% (n=1)	21.62% (n=8)	75.68% (n=28)
Vitamin E (µg)	4.98±3.06 (0.5-13.53)	75.68% (n=28)	13.51% (n=5)	10.81% (n=4)
Isoflavone (mg)	0.80±1.66 (0-9.069)	*	*	*
Flavones (mg)	171.50±60.87 (82.3-314.52)	*	*	*

Note- * refers to RDA not given by ICMR

intake data is given in Table 6. Intake of protein, visible fat, invisible fat, calcium, phosphorus, iron, magnesium, vitamin A, vitamin D, vitamin E, vitamin K were below the RDA in the diets of about 37.84 per cent (14), 29.73 per cent (11), 5.41 per cent (2), 16.22 per cent (6), 0 per cent, 59.46 per cent (22), 18.92 per cent (7), 100 per cent (37), 86.49 per cent (32), 75.68 per cent (28), 2.70 per cent (1) women, respectively. Similar results have been found in the study conducted by Aggarwal *et al.* (2011) wherein the dietary energy, protein and calcium intake was found below the RDA in case of 23 per cent, 16.4 per cent and 19 per cent of women with low BMD.

Physical activity exerts a strong positive impact on bone and muscle health. It also helps to maintain normal weight and metabolism of the body. The average time spent for performing household activities such as sweeping, scrubbing floor, washing clothes, washing utensils, gardening and any other household activity given in Table 7. Maximum *i.e.* 72.97 per cent (27) women were involved in sedentary lifestyle which is a risk factor for low bone mineral density. In another study also 46.8 per cent peri- and post-menopausal women with low BMD and 33 per cent with normal BMD were involved with low level of physical activity (Aggarwal *et al.*, 2011). Thus, sedentary lifestyles contribute towards increasing the risk of low bone mineral density and other degenerative diseases.

Data revealed that 72.97 per cent (27) enrolled women were involved in performing some exercise or physically active leisure activities as shown in Table 8. The most preferred exercise was walking. Thus, behaviour modification could further help such women in improving their lifestyle practices and hence their Bone Mineral Density.

Musclo-skeletal problems were reported by several women; 43.24 per cent (16) suffered from joint and back pain. Majority *i.e.* 29.73 per cent women reported that their wrist movements were flexible, while performing chores such as cooking. A higher prevalence (61 %) of joint and muscle pain have been reported by Sharma and Khandelwal (2010). In our study, it was found that that during postmenopausal phase, stamina to perform physical activities decreases due to increasing knee stiffness and reduced flexibility of muscles and joints.

It was noted that the first degree female relatives (mother and sister) of 18.92 per cent (7) women had suffered from fractures in their postmenopausal years. Data revealed that 75.68, 18.92 and 5.40 per cent women were having normal BMD, osteopenia and osteoporosis, respectively. The commonly reported peri-menopausal symptoms were hot flushes, facial flushes, palpitation, panic attacks as well as generalized aches and pains (Fig. 1).

Reported postmenopausal symptoms were pain in joints and backache, bloated abdomen, anxiety, constipation, painful intercourse, insomnia, numbness/ tingling in the skin of arms/ legs, irritability, perspiration, dry vagina, itchy vagina, headache/ joint pain, depression, nervousness, loss of confidence and dizziness graphically represented in Fig. 2.

The systolic and diastolic blood pressure values of enrolled women were categorized on the basis of the categorization given by the American Heart Association (AHA, 2011), refer Table 9. The mean blood pressure values tend to remain lower in women than men during the pre-menopausal years. However, this trend is not

Table 7 : Household activities- duration

Details of time spent	Sweeping	Scrubbing floor	Washing clothes	Cleaning utensils	Gardening	Any other
Mean (min.)±SD	16.25±3.74	15±2.47	25.36±12.28	11.25±3.61	27.04±4.55	12.5±3.51
Range (min-max.)	15.00- 17.50	0.00- 15.00	10.00- 60.00	10.00- 15.00	4.29- 60.00	10.00- 15.00
Percentage (n) (multiple responses)	10.53% (n=2)	5.26% (n=1)	26.32% (n=5)	5.26% (n=1)	42.11% (n=8)	10.53% (n=2)

Note: bracket () gives information on number of subjects.

Table 8 : Time spent on exercise **(n= 27)**

Details of time spent	Type of exercises			
	Flexible exercise	Aerobic exercise	Anaerobic exercise	Yoga
Mean±SD duration(min.)	40.63±13.43	42.47±24.84	26.61±9.95	43.17±24.62
Range (min.-max.)	20.00- 52.50	14.29- 90.00	10.00- 51.43	12.50-120.00
Percentage (n) (multiple responses)	14.81% (n=4)	81.48% (n=22)	14.81% (n=4)	33.33% (n=9)

Note: bracket () gives information on number of subjects.

observed during the post-menopausal years. Studies have indicated that salt-sensitivity increases during the post-menopausal years. This coupled with changes in hormone concentrations increase the risk of women to develop hypertension during the latter years of life (Pechère-Bertschi and Burnier, 2004 and Brinson *et al.*, 2014).

Other diseases/disorders diagnosed were diabetes, hypertension, hyper/hypo-thyroidism, ovarian cancer and gynecological surgeries to name a few (Fig. 3). These diseases have profound influence on the overall health and wellbeing of women especially during latter years of life.

Data on biochemical parameters *i.e.* total calcium, hemoglobin and vitamin D parameters as given in Table 10 below indicate the presence of micro-nutrient insufficiency/deficiencies; the prevalence being highest for vitamin D. Vitamin D deficiency coupled with low dietary intake of calcium/calcium deficiency increase the risk for low BMD and subsequent osteoporotic fractures. Several studies have highlighted the need for calcium and vitamin D supplementation during peri- and post-menopausal years (Gupta, 1996, Gennari, 2001; Aggarwal *et al.*, 2011 and Bhan *et al.*, 2015)).

Several women were taking nutrient supplements of multivitamins, calcium and vitamin D, as shown in Table 11. Majority *i.e.* 87.5 per cent (7) women out of 36.36 per cent (8) women taking vitamin D supplements had normal serum vitamin D level. Exposure to UV rays of sun helps in the activation of vitamin D. 95.59 per cent (35) women usually exposed themselves to sun rays; the average duration being 20.28 ± 18.81 (0- 70) minutes. However, the factors favouring and hindering absorption/utilization of UV rays could not be ascertained in the study. Hence nutrient supplements become necessary for better prognosis in bone health of postmenopausal women if the diet (and lifestyle) cannot provide optimum nutrition.

Spearman correlation and linear regression co-efficients were calculated. Spearman correlation and regression co-efficient correlation were used for assessing the relation of nutrient intake with serum vitamin D and Bone Mineral Density (dependent variable), refer Table 12.

Spearman correlation and linear regression co-efficient correlation were calculated to see the correlation between serum vitamin D levels and Bone Mineral Density with nutrient intake and $p<0.05$ was considered as statistically significant. Energy and nutrients such as protein, fat- visible and invisible, fibre, calcium, phosphorus, iron, magnesium, vitamin D, vitamin A, vitamin K, vitamin E, total folic acid, isoflavone and flavones were not found significantly correlated with both the dependent variables *i.e.* no correlation was found statistically significant.

There was no significant correlation found of serum vitamin D with all nutrient intakes *i.e.* energy, protein, carbohydrate, fibre, calcium, phosphorus, iron, magnesium, vitamin D, vitamin A, vitamin K, vitamin E, total folic acid, isoflavones, visible fat and invisible fat. Similarly correlation was found insignificant between Bone Mineral Density and all nutrient *i.e.* energy, protein, carbohydrate, fibre, calcium, phosphorus, iron, magnesium, vitamin D, vitamin A, vitamin K, vitamin E, total folic acid, visible fat and invisible fat, refer Table 12. Only there was fair correlation found between isoflavone and vitamin D ($r= 0.476$ and $p= 0.005$).

The present research work was carried out to study the nutrition and health status of postmenopausal

Table 9 : Categorization of patients on the basis of blood pressure (AHA, 2011)

(n=37)	Normal		Pre-hypertension		Hypertension stage1	
	Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic
Mean ±SD	109.57±2.95	70.77±4.67	125.05±5.13	81.19±2.71	140.00±0.00	90.00±0.00
Percentage (n)	37.84% (n=14)	43.24 % (n=16)	51.35% (n=19)	43.24% (n=16)	10.81% (n=4)	13.51% (n= 5)

Note: bracket () gives information on number of subjects.

Table 10 : Biochemical parameters and their categorization (WHO, 2012)

	Haemoglobin (n=37)		Total calcium (Ca)(n=37)		Vitamin D (n=33)	
	Deficient	Normal	Deficient	Normal	Deficient	Normal
Mean ±SD	10.86±0.62	12.58±0.72	8.78±0.16	9.66±0.39	8.48±2.70	17.53±10.15
Percentage (n)	18.92% (n=7)	81.08% (n=30)	16.22% (n=6)	83.78% (n=31)	40.54% (n=15)	57.58% (n=18)

Note: bracket () gives information on number of subjects.

women. The participants were enrolled according to inclusion and exclusion criteria stated in the study. Data were collected on general information, socio- economic status, anthropometric measurements (height, weight, hip and waist circumference), clinical parameters (blood pressure, dual energy x- ray absorptiometry (DXA), hemoglobin, serum calcium, 1, 25 Hydroxyvitamin D), dietary habits/ intake, physical activity, duration of sun-exposure. Majority of women did not have normal serum vitamin D. Deficient intake of energy, protein and vital micronutrients such as vitamin A, vitamin D, vitamin E and vitamin K, calcium, phosphorus, iron, magnesium,

Table 11 : Consumption patterns of nutrient supplements

Calcium supplement (%)	Vitamin D supplement (%)	Multivitamin supplement (%)
54.55% (n=12)	36.36% (n=8)	63.64% (n=14)

Note: bracket () gives information on number of subjects

Table 12 : Linear regression and correlation of nutrient intake with serum vitamin D levels and bone mineral density

Nutrients intake	Serum vitamin D (n=33) correlation co-efficient (R^2) p- va	Regression correlation co-efficient(R^2) p- va	BMD (n=37) correlation co-efficient(R^2) p- va	Regression correlation co-efficient (R^2) p- va
Energy (kcal)	0.061	0.000	-0.0001	0.000
	0.734	0.997	0.999	0.978
Protein (g)	0.118	0.013	-0.084	0.022
	0.510	0.523	0.617	0.377
Carbohydrate (g)	-0.053	0.018	0.108	0.045
	0.769	0.454	0.524	0.209
Fibre (g)	0.144	0.002	0.370	0.063
	0.423	0.801	0.134	0.134
Calcium (mg)*	0.128	0.001	0.013	0.000
	0.477	0.849	0.937	0.949
Phosphorus (mg)	0.099	0.021	-0.028	0.000
	0.581	0.425	0.869	0.950
Iron (mg)	0.175	0.015	0.036	0.017
	0.327	0.495	0.830	0.444
Magnesium (mg)	-0.082	0.028	0.080	0.040
	0.646	0.356	0.636	0.229
Vitamin D (mcg)	0.073	0.001	-0.147	0.038
	0.686	0.902	0.382	0109
Vitamin A (µg)	0.079	0.000	-0.129	0.615
	0.659	0.803	0.444	0.165
Vitamin K (mg)	0.014	0.000	-0.148	0.012
	0.935	0.922	0.381	0.513
Vitamin E (µg)	-0.298	0.095	0.080	0.020
	0.091	0.081	0.636	0.399
Total Folic Acid (µg)	0.026	0.019	-0.166	0.002
	0.885	0.434	0.326	0.821
Isoflavone (mg)	0.476	0.015	0.162	0.006
	0.005	0.005	0.335	0.649
Flavones (mg)	-0.058	0.008	0.049	0.002
	0.745	0.621	0.771	0.786
Visible Fat (g)	0.081	0.000	0.193	0.014
	0.654	0.944	0.541	0.485
Invisible Fat (g)	0.045	0.012	0.128	0.021
	0.802	0.541	0.283	0.395

* Dietary intake of calcium, does not include intake from supplement

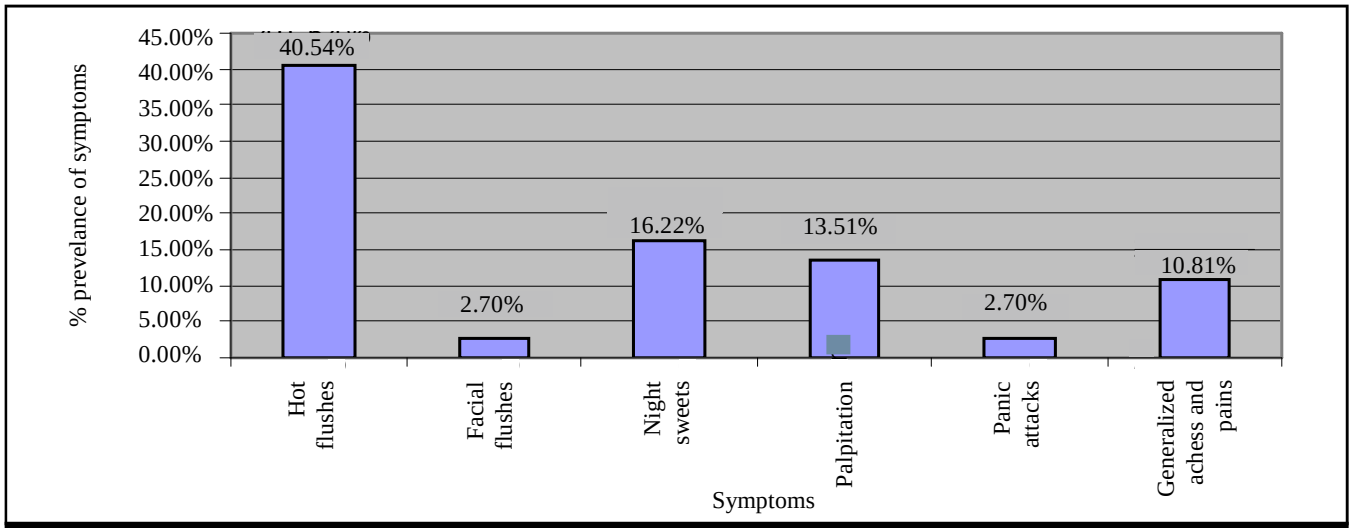

Fig. 1 : Peri-menopausal symptoms (multiple responses)

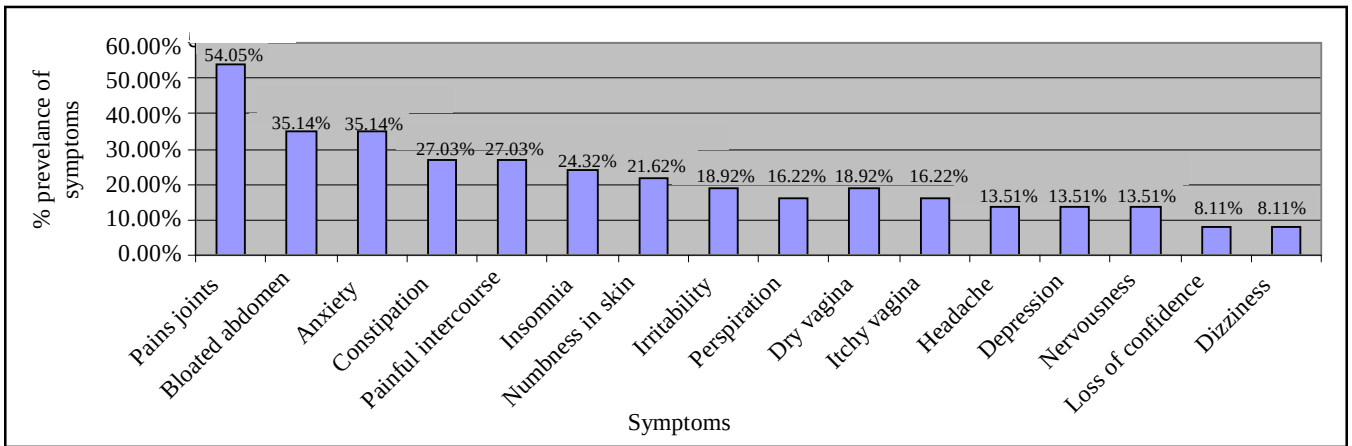

Fig. 2 : Post- Menopausal symptoms (multiple responses)

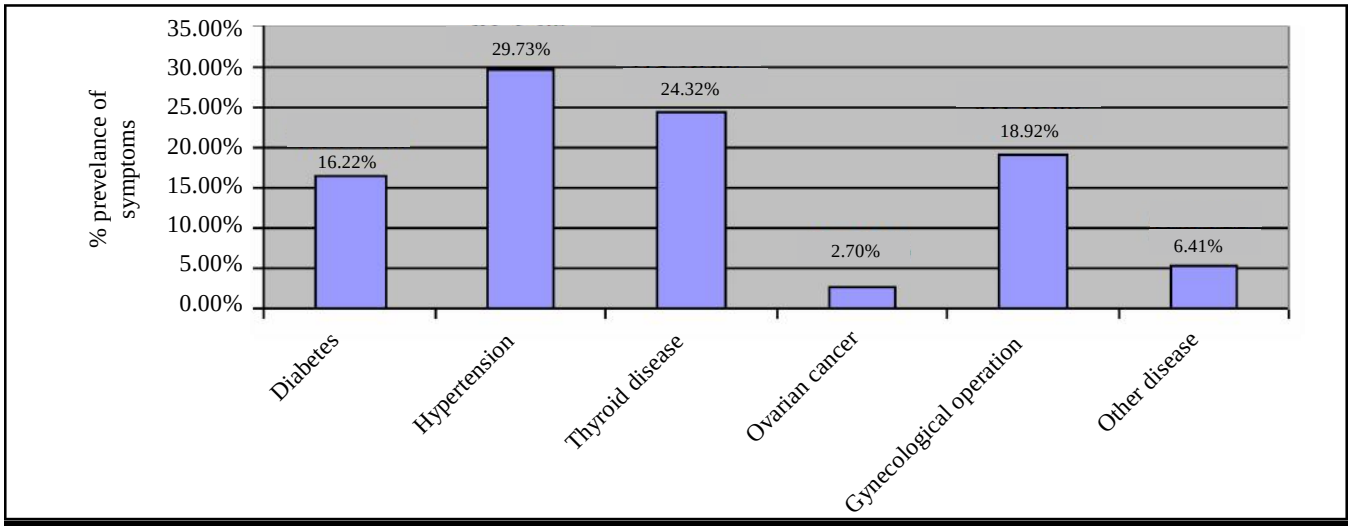

Fig. 3 : Health status of post-meopausal women

phytochemicals (Alekel *et al.*, 2010) (*i.e.* flavonoids, isoflavones) etc. could be contributing to low bone mineral density.

Of various fragility fractures, which represent the major complication of osteoporosis, vertebral and hip fractures are associated with pronounced morbidity and excess mortality. Thus, the prevention and treatment of osteoporosis should be aimed at reducing substantially the risk of fracture. It can thus be concluded that educational interventions should be targeted towards the consumption of a nutritionally balanced diet throughout life especially during the menopausal years. Behaviour modifications to result in correct food choices, active lifestyle and adequate sum exposure are necessary to maintain optimum bone health during postmenopausal years. This study could be done on a larger sample size enrolling postmenopausal women from different parts of India and belonging to same or different socio economic groups and also from rural areas as well as urban slums. This would provide a clearer picture regarding the nutritional and lifestyle related factors which may influence bone health of the study population.

Acknowledgement :

I am indebted to Dr. Rinku Sengupta Dhar, consultant gynecologist, Sitaram Bhatia Institute of Science and Research (SBISR), New Delhi, who helped me to be committed throughout this venture by her unflinching support in all my efforts.

Authors' affiliations:
SUKHNEET SURI, Department of Food and Technology, Vivekananda College (University of Delhi), DELHI, INDIA
Email : suri.fnve@gmail.com

■ REFERENCES

Aggarwal, Neelam, Raveendran, Ainharan, Khandelwal Niranjan, Sen Ramesh Kumar, Thakur J.S., Dhaliwal Lakhbir Kaur, Singla Veenu, and Rajaram Manoharan Sakthivel Rajan (2011). Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women. *J. Midlife Health*, **2**(2):81-5

Alekel, D.L., Loan M.D.V., Kochler, K.J., Hanson, L.N., Stewart, J.W., Hanson, K.B., Kurzer, M.S. and Peterson, C.T. (2010). The soy isoflavones for reducing bone loss (SIRBL) study: a 3- y randomized controlled trial in postmenopausal women. *American J. Clinical Nutrition*, **91**: 218- 230.

Anderson, J.J.B., Mahan, L.K. and Escott- Stump (2010). S. Krause's Food, Nutrition and Diet Therapy, Saunders/ Elsevier. 12: 337-362.

Battacharya, S.M. and Jha, A. (2010). Effect of transdermal estradiol gel and oral tibolone on health- related quality of life after surgical menopause. *Internat. J. Gynaecol. & Obstetrics India, Elsevier Ireland Ltd.*, **110**: 321-324.

Bhan, Nirojini Bhat, Kour, Guneet and Masoodi, Farhat (2015). Assessment of menopausal symptoms in perimenopause and postmenopausal working women (above 40 years) in Urban area of Jammu city. *Internat. J. Appl. Home Sci.,* **2** (3&4) : 81-86.

Brinson, K.N., Rafikova, O. and Sullivan, J.C. (2014). Female sex hormones protect against salt-sensitive hypertension but not essential hypertension. *American Journal of Physiology, Regulatory Integrative and Comparative Physiology*, 15; **307**(2):R149-57.

Brooks, J.D., Ward, W.E., Lewis J.E., Hilditdh, J., Nickell, L., Wong, E. and Thompson, L.U. (2004). Supplementation with flaxseed alters estrogen metabolism in postmenopausal women to a greater extent than does supplementation with an equal amount of soy. *American J. Clinical Nutrition*, *Elsevier*, **79**: 318- 325.

Burke, G.L., Legault, C., Anthony, M., Bland, D.R., Morgan, T.M., Naughton, M.J., Leggett, K., Washburn, S.A. and Vitolins, M.Z. (2003). Soy protein and isoflavone effects on vasomotor symptoms in peri- and postmenopausal women: the Soy Estrogen Alternative Study. *Menopause*, **10** : 147–153.

Cashman, K.D. (2007). Diet, nutrition and bone health. Journal of Nutrition, *American Society for Nutrition*, **137**: 2507S- 2512S.

Chattha, R., Nagarathna, R., Padmaltha, V. and Nagendra, Hr. (2008). Effect of yoga on cognitive functions in climacteric syndrome: a randomized control study. *Internat. J. Obstetrics & Gynaecology*, **115**: 991- 1000.

Finkelstein, J.S., Brockwell, S.E., Mehta, V., Greendale, G.A., Sowers, M.R., Ettinger, B., Lo, J.C., Johnston, J.M., Cauley, J. A., Danielson, M. E. and Neer, R.M (2008). Bone mineral density changes during the menopause transition in a multiethnic cohort of women. *J. Clinical Endocrinol. & Metabolism*, **93**(3): 861-868.

Gennari, C. (2001). Calcium and vitamin D nutrition and bone disease of the elderly. *Public Health Nutrition*, **4**(2B):547-59.

Gupta, A. (1996). Osteoporosis in India—the nutritional hypothesis. *National Medical J. India*, **9**(6):268-274.

Heaney, R.P. and Recker, R.R (1982). Effect of nitrogen, phosphorus and caffeine on calcium balance in women. *J. Laboratory & Clinical Medicine*, **99** : 46- 55.

Indian council of medical research (ICMR), Nutrient requirements and recommended dietary allowances for Indians (2010). National institute of nutrition Indian council of medical research, NIN, Hyderabad, A.P.. 12: 194-236.

Järvinen, R., Tuppurainen, M., Erkkilä, A.T., Penttinen, P., Kärkkäinen, M., Salovaara, K., Jurvelin, J.S. and Kröger, H. (2012). Associations of dietary polyunsaturated fatty acids with bone mineral density in elderly women. *European J. Clinical Nutrition*, **66**(4):496-503.

Knight, D.C., Howes, J.B., Eden, J.A. and Howes, L.G. (2001). Effects on menopausal symptoms and acceptability of isoflavone-containing soy powder dietary supplementation. *Climacteric*., **4** : 13–18.

Lucas, E.A., Wild, R.D., Hammond, L.J., Khalil, D.A., Juma, S., Daggy, B.P., Stoeker, B.J. and Arjmandi, B.H. (2002). Flaxseed improves lipid profile without altering biomarkers of bone metabolism in postmenopausal women. *J. Clinical Endocrinol. & Metabolism*, **87**(4):1527-1532.

Maria, A. and Singh, F. (2000). *Exercise, nutrition and the older women* (wellness for women over fifty), CRC Press. 1st Ed.

McCarty, C.A. (2008). Sunlight exposure assessment: can we accurately assess vitamin D exposure from sunlight questionnaire? *American J. Clinical Nutrition*, **87**: 1097S-1101S.

NahlaElbostany, A., Hala, A. Thabet and Hanan, F. Ahmed (2013). The effect of supplementation with flaxseed and its extract on bone health. *Nature & Sci.*, **11**(5).

Orchard, T.S., Pan, X., Cheek, F., Ing, S.W. and Jackson, R.D. (2012). A systematic review of omega-3 fatty acids and osteoporosis. *British J. Nutrition*, **107** (Suppl 2) : S253-60.

Pechère-Bertschi, A. and Burnier, M. (2004). Female sex hormones, salt, and blood pressure regulation. *American J. Hypertension*, **17**(10):994-1001.

Rikkonen, T., Salovaara, K., Sirola, J., Karkkainen, M., Tuppurainen, M., Jurvelin, J., Honkanen, R., Alhava, E. and Kroger, H. (2010). Physical activity slows femoral bone loss but promotes wrist fractures in postmenopausal women: A 15- year follow- up of the OSTPRE Study. *J. Bone & Mineral Res.*, American Society for Bone and Mineral Research, **25**: 2332-2340.

Salve, H., Gupta, V., Palanivel, C., Yadav, K. and Singh, B. (2010). Prevalence of knee osteoarthritis amongst perimenopausal women in an urban resettlement colony in South Delhi. *Indian J. Public Health*, **54** : 155- 57.

Sharma, Seema and Khandelwal, Sunila (2010). Effective risk assessment tools for osteoporosis in the Indian menopausal female. *J. Midlife Health*, **1**(2): 79–85

Simbalista, R.L., Sauerbronn, V., Aldrighi, J.M. and Areas, J.A.G. (2010). Consumption of a Flaxseed- Rich food is not more effective than a placebo in alleviating the Climacteric symptom of postmenopausal women. *J. Nutrition*, American Society for Nutrition, **10** : 293- 98.

St. Germain, A., Peterson, C.T., Robinson, J.G. and Alekel, D.L. (2001). Isoflavone-rich or isoflavone-poor soy protein does not reduce menopausal symptoms during 24 weeks of treatment. *Menopause -J. North American Menopause Soc.*, **8**:17–26.

Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, Hoboken: John Wiley and Sons. 12th Edition: **21** : 688.

Weiss, L.A., Barrett- Connor, E. and Muhlen, D.V. (2005). Ratio of n-6 to n-3 fatty acids and bone mineral density in older adults: the Rancho Bernardo Study. *American J. Clinical Nutrition*, **81**: 934-938.

World Health Organization (2007). Scientific group on the assessment of osteoporosis at primary health care level.