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Efficacy of Dietary and Knowledge of Bone Health on Osteoporosis Prevention in Premenopausal Women

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Introduction

Osteoporotic affects approximately 50 million Indian people either osteoporotic or low bone mass with lower T-scores leads towards depression, dependency, disability and death [1-3]. In middle aged people, men observed with low bone loss but women experiences increased bone loss during pre-menopause and post menopause [4-5]. Unfortunately, 90% of women may not be getting enough calcium and recommended calcium intake for adult women is ranging from 500 to 1500 mg/day [6-7]. The balanced diet associated with vitamins and minerals are important to improve bone health and osteoporosis [8]. A study shows that Indian people had lack of knowledge about bone health and a need for bone health education [9]. So it is major health issue among Indian women due to lack of calcium intake and knowledge. Therefore, current study focuses to prevent osteoporosis, provide structured health education, dietary calcium intake and changes in lifestyle to pre-menopausal women in advance.

Methods

Study design

In this study, quantitative and true experimental study was used for study design. An accredited laboratory's experienced phlebotomist collected blood samples using a disposable syringe and QUS method was used to know BMD based T-Scores from the participants. Then the selected women were administered with questionnaire included the details about demographic variables and they were randomly divided into two equal groups, which contains one control group and experimental group. The experimental group is further divided into two functional group of ten. Every day each functional group was selected for structured health education which includes general information definition, causes, clinical manifestation, diagnostic evaluation, management and preventive & control measures of osteoporosis. In alternate days each functional group was selected for health education for twenty minutes using flash cards and they were instructed 20 minutes morning walk and asked to consume calcium enriched dietary supplementation of ragi laddu (or ragi ball) weight of 150 grams (calcium is 525.5mg) for three days in a week and laddu preparation method also shared. To make quantitative research for nutritional assessment 24-hour hour diet recall interview was conducted and recorded the values. Pamphlets with brief information about osteoporosis prevention were distributed among experimental group and control group did not receive any intervention.

Participants

This study was conducted for a year from April 2019 to April 2020 in women self-help group called Kanchi Sangamam situated at Singapermalkovil, near Chennai city, in the South Indian state of Tamil Nadu. This study set inclusion and exclusion criteria for identifying participants. The exclusion criteria were, (1) cognitive impairment (2) chronic illness affected with mental health problems (3) Hormone Replacement Therapy (HRT) or had osteoporosis already (4) denied to participate in structured health education. The inclusion criteria were, (1) Age between 30-40 years (2) T-scores ranging from -1 to - 4 (3) willingness to participate in current study (4) Language proficiency: both English & local language-Tamil (5) willingness to attend structured health education. All those 180 premenopausal women, 83 women met the inclusion criteria and from them 40 were chosen based on the lottery method and agreed to participate in the study and gave informed written consent.

Ethical approval and Patient consent

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by Institutional Ethical Committee of Saveetha Medical College Hospital (Approval number: 006/04/2019). The investigator collected the demographic variables of participants after obtained the permission from the concerned authorities and consent from the participants.

Ragi Laddu preparation and nutrition values

Ragi (Finger Millet) is important food in daily meal of southern India, which has rich nutrient profiles. Of all millets and cereals, ragi has highest amount of calcium (344 mg %) and potassium (408 mg %) in 100g of edible portion [10]. Other than calcium it has nutrition value like high amount of dietary fibre, minerals, and amino acids. Ragi can be consumed in any form like noodles, vermicelli, pasta, Indian sweet mixes and also bakery products. Current study focuses consumption of ragi in sweet format.

The raw materials required for ragi sweet ball preparation were weighed as ragi flour- 1 cup (100g), powdered jaggery - ½ cup (50g) and ghee - 3 table spoons. Add one tbsp. of ghee in deep frying pan and roast ragi flour about 5-7 mins in low flame. Add powdered jaggery and 2 tbsp of melted warm ghee to hold the mix together. Use hands to make balls of weight 150g from the mix and nutrition values of ragi ball were listed (Table 1).

Table 1: Nutrition Value of Ragi Ball

Ingredients	Quantity	Energy	Protein	Fat	Calcium	Iron
Ragi	100 grams	328	7.3	1.3	344	3.9
Jaggery	50 grams	176.5	0.75	0.15	181.5	-
Ghee	2 tbsp	90	-	10	-	-
Total		594.5	8.05	11.45	525.5	3.9

Study measurements and Statistical analysis

The demographic characteristics of pre-menopausal women were age, marital status, education, and religion, number of children, type of family, socioeconomic status, family history of osteoporosis, menarche age, menstrual regularity, dietary habits and prior knowledge regarding osteoporosis. A 24-hour nutritional recall assessment was done and recorded them in a diary to monitor the diet intake. The standard methods of blood test were conducted to measure Serum Calcium, Serum Phosphorus and Alkaline phosphatase (ALP) by colorimetric method, Molybdate UV method and Liquid Kinetic Method respectively. The complete statistical analysis of quantitative variables was accomplished using SPSS version 20. Master data sheet of categorical variables was summarized using frequency, percentage and quantitative variables were summarized using mean, standard deviation, median to assess the knowledge and repeat measurement of dietary supplementation. Kruskal-Wallis test and socio-demographic variables test were performed to study and compare the association of knowledge and diet $p < 0.05$ is considered as statistically significant.

Results

Assessment of knowledge on osteoporosis

Twenty multiple choice questionnaires were prepared and focused on current knowledge on osteoporosis of selected 40 participants. The knowledge on osteoporosis is measured using three-point scale ranged from 0-10 inadequate, 11-15 moderately adequate and 16-20 adequate knowledge. The level of knowledge observed on osteoporosis among selected premenopausal women in the experimental and control group (Table 2). In the pre-test both experimental and control group had same level of knowledge as 0% adequate, 10% moderately adequate and 90% (18 women) inadequate. After structured health education in experimental group the significant difference was observed on level of knowledge as 90% adequate, 10% moderately adequate and 0% inadequate and no changes were observed in control group. The significant association between demographic variable and structured health education on osteoporosis before and after the education provided to experimental group of twenty premenopausal women (Table 3). Source of information ($p = 0.047$) is significantly associated with knowledge level on osteoporosis. After the structured health education, the experimental group inadequate and moderately adequate participants knowledge levels were improved to moderately adequate and adequate levels.

Table 2: Frequency and Percentage Distribution of Osteoporosis Knowledge Level among Premenopausal Women in the Experimental and Control Group (n = 20 +20)

Group	Knowledge level	Pre-Test		Post Test	
		No.	%	No.	%
Experimental Group	Inadequate	18	90.0	0	0
	Moderately adequate	2	10.0	2	10.0
	Adequate	0	0	18	90.0
Control Group	Inadequate	18	90.0	18	90.0
	Moderately adequate	2	10.0	2	10.0
	Adequate	0	0	0	0

Table 3: Association of Pre-Test and Post-Test On Osteoporosis Knowledge Level among Premenopausal Women in Experimental Group

Demographic variables		Pre-Test	Post Test
		Kruskal-Wallis H-Test & *p*-value	Kruskal-Wallis H-Test & *p*-value
Age			
30 - 35 years	10	$\chi^2 = 5.402$ d.f = 1, p = 0.020, Sa	$\chi^2 = 2.181$ d.f = 1, p = 0.140, N.Sb
35 - 40 years	10		
Marital status			
Married	17	$\chi^2 = 0.030$ d.f = 1, *p* = 0.862, N. S	$\chi^2 = 1.069$ d.f = 1, p = 0.301, N. S
Unmarried	0		
Widow	3		
Divorce	0		
Educational qualification			
Illiterate	3	$\chi^2 = 3.576$ d.f = 2, p = 0.167, N. S	$\chi^2 = 4.257$ d.f = 2, p = 0.119, N. S
Primary education	15		
High school and above	2		
Religion			
Hindu	14	$\chi^2 = 1.872$ d.f =2, p = 0.392, N. S	$\chi^2 = 4.496$ d.f = 2, p = 0.106, N. S
Christian	4		
Muslim	2		
No. of children			
No children	15	$\chi^2 = 1.112$ d.f = 1, p = 0.292, N. S	$\chi^2 = 1.402$ d.f = 1, p = 0.236, N. S
1 to 2 children	5		
3 to 5 children	0		
Type of family			
Nuclear family	15	$\chi^2 = 1.112$ d.f = 1, p = 0.292, N. S	$\chi^2 = 1.402$ d.f = 1, p = 0.236, N. S
Joint family	5		
Socio economic status			
Low	12	$\chi^2 = 1.724$ d.f = 1, p = 0.189, N. S	$\chi^2 = 1.010$ d.f = 1, p = 0.315, N. S
Middle	8		
High	0		
Family history of osteoporosis			
Yes	2	$\chi^2 = 1.727$ d.f = 1, p = 0.189, N. S	$\chi^2 = 0.790$ d.f = 1, p = 0.374, N. S
No	18		
Menarche Age			
< 10 years	3	$\chi^2 = 1.179$ d.f = 2, p = 0.555, N. S	$\chi^2 = 0.649$ d.f = 2, p = 0.723, N. S
10 - 13 years	12		
> 13 years	5		
Menopausal regularity			
Regular	16	$\chi^2 = 0.011$ d.f = 1, p = 0.917, N. S	$\chi^2 = 1.052$ d.f = 1, p = 0.305, N. S
Irregular	4		
Dietary habits			
Vegetarian	4	$\chi^2 = 1.187$ d.f = 1, p = 0.276, N. S	$\chi^2 = 0.592$ d.f = 1, p = 0.442, N. S
Non-vegetarian	16		
Source of information			
Mass media	2	$\chi^2 = 1.727$ d.f =1, p = 0.189, N. S	$\chi^2 = 3.931$ d.f = 1, *p = 0.047, S
Friends	0		
Health personnel	0		
None	18		

[a]S – Significant, [b] N.S – Not Significant, *$p < 0.05$ significant association between demographic variable and structured health education

Calcium diet supplementation

The investigator prepared standardized dietary supplements which were verified by dietician for its appearance, flavour, consistency, taste, and the proportion of ingredients. The calcium present in food items were measured in milligrams based on Nutritive value of Indian foods chart [11]. The measured calcium value was compared with daily calcium intake recommended for Indian woman by the ICMR expert group. The comparison of calcium dietary intake between experimental and control group reveals significant differences after dietary supplementation (Figure 1). The prescribed calcium level per person per day is ≥ 600mg. T-Score is used as a reference measure to analyse the BMD of premenopausal women and observed that post test showed improvements from Low Bone Density (Osteopenia) stage to normal level after dietary approaches followed (Figure 3).

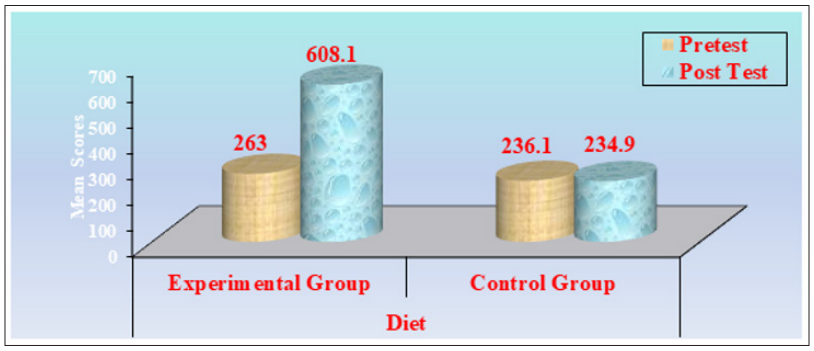

Figure 1: Diet Comparison among Premenopausal Women between Experimental and Control Groups

Discussion

Though many options are present to reduce the risk of osteoporosis, the physical activity and nutrition food are essential to reduce the risk among menopausal women. In present study we concentrated more towards structured education and diet with high levels of calcium, vitamin-D and minerals to provide some protection against osteoporosis. The biochemical parameters like serum calcium, serum phosphorus and alkaline phosphate levels are considerably changed (Figure 2) in experimental group by following prescribed the dietary approaches like calcium rich ragi ball and no change was observed in control group participants.

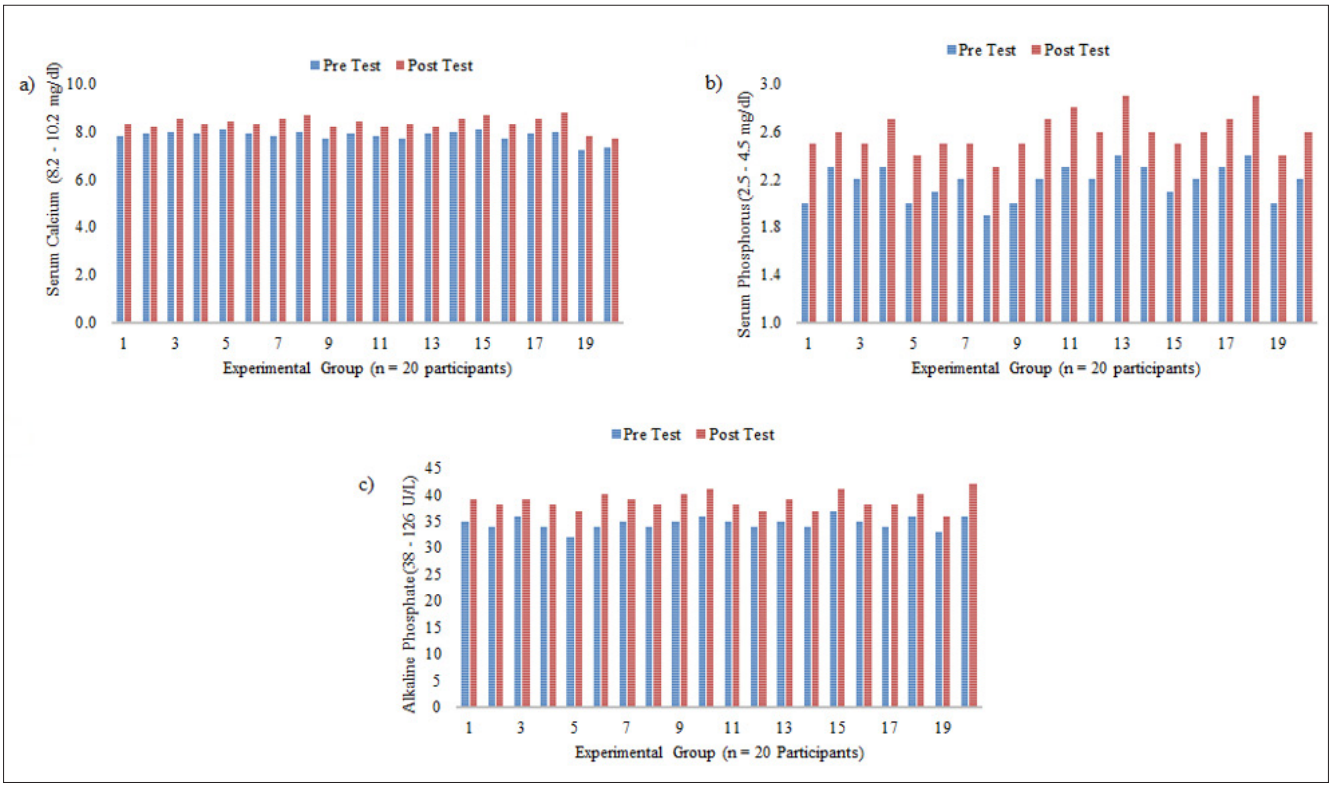

Figure 2: Shows Biochemical Parameters Improvements Observed Pretest and Posttest of 20 Experimental Group Premenopausal Women After the Dietary Approaches Followed. A) Serum Calcium Level Changes b) Serum Phosphorus Level Changes c) Alkaline Phosphate Level Changes.

It was also observed that ratio of calcium and phosphorus was within the acceptable ratio Ca/P is 3.5 mg/dL. The high phosphorus and lack of calcium can lead to bone tissue damage and increases the chances of osteoporosis, so acceptable ratio of phosphorus and calcium is 0.5-1.5:1. The risk of bone fracture can be increased and bone density is reduced when vitamin D serum level is less than 20 ng/ml [12]. The observations revealed that the neutral or alkaline balanced food, potassium and calcium rich foods like fruits, vegetables and dairy products can be consumed throughout the life time to improve the bone health [13]. The 24-hour dietary recall method was followed with daily monitoring of prescribed diet in experimental group. It was observed that by consuming calcium rich foods like ragi ball and dairy products the BMD was improved in experimental group for three months and as expected the control group participants BMD were not improved as no dietary followed (Figure 3). The habitual dietary intake is important to maintain the dietary calcium intake and BMD which elucidate skeletal health on Asian populations [14].

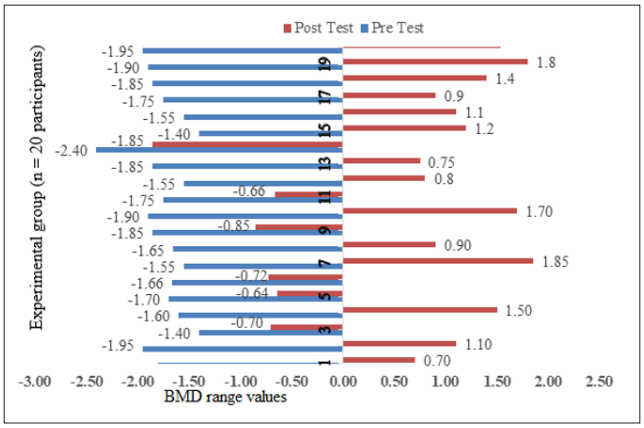

Figure 3: Bmd Improvements After the Dietary Approaches Followed in Experimental Group Premenopausal Women.

Our study evaluated the OP knowledge level of premenopausal women in which 20 questions were framed related to concept and diagnosis of OP, risk factors involved, preventive factors and treatment of OP. The pre-test results of current study for both experimental group and control group shown that 90% premenopausal women had inadequate knowledge and only 10% had moderately adequate knowledge. The structure health education like general information about OP, evaluating, managing and preventing OP were provided to experimental group using flash cards. The knowledge outcome of participants was improved to 90% adequate, 10% moderately adequate and 0% inadequate. Women's level of knowledge on osteoporosis, risk factors, treatments and its complications were average. Creating awareness about risk and importance of diet among pre and postmenopausal women using magazine, pamphlets and media advertisements can prevent osteoporosis [15]. The present study shows that OP knowledge level and prescribed diet provides most effectiveness in premenopausal women for prevention of osteoporosis. The current study has few limitations like sample size of the premenopausal women is less and this can be larger. This study can be done in large area of women representing country. Other nutritional factors like vitamin K, vitamin B which were not consider as a part of study.

Conclusions

This study concludes that, three months of structured health education and dietary supplementation significantly improved bone health among the experimental group compared with control group women. To prevent morbidity and mortality associated with osteoporosis and other disorders associated with calcium deficiency during the postmenopausal period educated the experimental group about dietary calcium and the need of calcium. Also, awareness program was conducted among control group.

Conflict of Interest: None.

Acknowledgements

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