ORIGINAL RESEARCH ARTICLE

Effectiveness of Nutritional Intervention on Bone Mineral Density among Women Aged 30-50 Years in South India

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ABSTRACT

Introduction: By 2050, low bone mineral density in women is expected to increase by 40% globally, considerably increasing the burden of osteoporosis in future generations, which necessitates greater focus on preventive measures. Hence, it was planned to study the effectiveness of calcium rich nutritional intervention on bone mineral density among women aged 30-50 years in South India.

Methods: A quasi-experimental pre-test and post-test control group design was conducted among randomly selected 20 urban and rural women aged 30-50 years. Calcium rich nutritional mix was given for 16 weeks to the interventional arm and for control arm, education on importance of calcium rich diet was given. Bone mineral density was measured by DEXA scan pre and post intervention. Descriptive and inferential statistics were used to analyse the data.

Results: Before intervention, all the women (100%) had mildly reduced bone mineral density; post intervention, majority of the women (80%) had normal bone mineral density, only 20% had mildly reduced bone mineral density. In the control group, 100% had mildly reduced bone mineral density before receiving health education and after 16 weeks of education, 90% had mildly reduced bone mineral density and only 10% had normal bone mineral density.

Conclusion: Calcium rich nutritional intervention given to the experimental group women resulted in a significant improvement in their bone mineral density. However, risk can be lowered by leading a healthy lifestyle that includes enough quantities of dietary calcium, vitamin D, and protein, frequent weight-bearing activity.

Keywords: Bone Mineral Density, Nutritional Intervention, Porous bones, Middle aged women

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INTRODUCTION

The mineral content of bone tissue is measured by bone mineral density.[1,2] Low bone mineral density (BMD) is the primary cause of osteoporosis and osteopenia, both of which increases the risk of fragility fracture in elderly women.[3,4]The prevalence of osteoporosis in women varies by age group, ranging from 8% to 62% in India.[5,6]

By 2050, the prevalence of low bone mineral density is expected to increase by 40% globally, considerably increasing the burden of osteoporosis on future generations.[7,8]Calcium is the predominant component of bone since it makes up the majority of hydroxyapatite crystals or solid particles.[9,10] In the body, the preservation of blood calcium levels takes precedence over bone tissue. 99% of the calcium reserves in the body are found in bone.[11] Because calcium accounts for 40% of the minerals in bone. Dietary calcium consumption and bone mineral density are positively correlated. Foods made with ragi flour, soy flour, wheat flour, milk powder, flax seeds, sesame seeds, and oats are rich in calcium concentration. Consuming 100 gm of ragi gives 344 mg of calcium. Milk is another good source, as it contains all of the elements and vitamins needed for the development of healthy bones, including calcium. Sesame seeds are an alkaline food that promotes bone health due to their high content of organic minerals such as calcium and zinc. Flax seeds are considered a nutritious powerhouse containing calcium, Omega-3 fatty acids, fiber, and protein. Taking calcium-rich food lessens the chance of bone loss, which further can prevent osteoporosis and other bone problems.[12]

The International Osteoporosis Foundation discovered that the average calcium consumption ranged between 175 and 1233 mg/day in 74 countries worldwide, which values are typically much lower than those recommended for the adult population. Over the last 45 years, dietary calcium intake has decreased in both rural and tribal India.[13,14] Adequate calcium consumption is one critical point for sustaining skeletal health.[15] Understanding the pattern of bone mineral density in women aged 30 to 50 years is another critical point for prevention of osteoporosis, for early diagnosis, and for treatment of its repercussions later in life. Bone mineral density is measured using quantification ultrasound (QUS), which is portable, inexpensive, and emits no ionizing radiation.[16] Women must be made aware of the importance of nutritional intervention in both disease prevention and management. Though many studies were conducted in the area of bone mineral density among women, the researchers could not find any valid study supporting calcium rich nutritional intervention on bone mineral density among southern Indian women. Hence, the researchers felt the need to assess the impact of calcium rich nutritional intervention on bone mineral density among women aged 30-50 years in South India.

METHODOLOGY

A quasi-experimental pre-test and post-test control group design was chosen for the study. The study was conducted in Chittoor, a district in Andhra Pradesh state, South India

Twenty women (10 from rural, 10 from urban) aged 30 - 50 years living in urban and rural areas of Chittoor district were included in the study.

Sample selection criteria: Study included women aged 30 to 50 years living in Chittoor district for the past 5 years, who do not have any loco-motor disabilities, who are not suffering from chronic health conditions or on chronic medication management.

Sampling technique: Sample were selected randomly by applying simple random technique from the selected rural and urban areas of Chittoor district. Those selected 20 samples were allocated to the intervention and control arm through simple randomization. Each arm was finally allotted with 10 samples (5 from rural, 5 from urban).

Data collection & analysis: Socio demographic details and lifestyle details were collected using a self-structured interview questionnaire at baseline. Bone mineral density was measured at baseline and at the end of 16 weeks of nutritional supplementation using Dual Energy Xray absorptiometry (DEXA).

The data was analysed using descriptive statistics (frequency, percentage, mean and standard deviation). Inferential statistics such as independent and paired t tests were used. All the statistical analysis was carried out at 5% level of significance with a p value of<0.05.

Intervention details: Intervention arm participants were given calcium rich nutritional mixture in powder form. The calcium rich nutritional mixture was prepared by the researchers with consultation of a nutritionist. It was made with ragi flour, wheat flour, sesame seeds and milk powder. 500 gms of this mixture gives 1890 Kcal and 3673 mg of calcium. All the participants were instructed to take 100 grams of the powder (which gives 735 mg of calcium) mixing with warm water every morning on an empty stomach. As per recommended dietary allowances, women aged 30-50 years require 1000 mg of calcium per day. This nutritious mix of 100 gms per day gives 735 mg of calcium and rest is considered from the regular dietary intake of the participants. Adherence of the intervention was verified by individual phone calls once every 2 days. Health information on the importance of a calcium-rich diet was given to the control arm participants by conducting a group education session after baseline data collection.

Study period: Study was conducted from June 2022 to December 2023

Ethical considerations: The Institutional Ethical Committee granted formal permission (by Vinayaka Mission's Annapoorna College of Nursing, IEC No:

Table 1: Demographics of women aged 30-50 years in experimental and control group

Variables	Experimental arm (n=10) N (%)	Control arm(n=10) N (%)
Age in years		
30-35	3(30)	3(30)
36-40	3(30)	2(20)
40-45	2(20)	2(20)
45-50	2(20)	3(30)
Educational status		
No formal education	1(10)	1(11.1)
Primary school	1(10)	1(11.1)
Secondary school	1(10)	1(11.1)
Diploma	5(50)	3(33.3)
Any degree	2(20)	3(33.3)
Occupation		
Government Service	1(10)	1(10)
Private Service	1(10)	1(10)
Business	1(10)	1(10)
Daily wager	1(10)	6(60)
Home maker	6(60)	1(10)
Religion		
Hindu	330)	3(30)
Christian	3(30)	3(30)
Muslim	2(20)	2(20)
Others	2(20)	2(20)
Age at menarche in years		
11	2(20)	5(55.6)
12	2(20)	1(11.1)
13	2(20)	1(11.1)
14	2(20)	1(11.1)
15	2(20)	1(11.1)
Marital status		
Married	5(50)	2(20)
Unmarried	1(10)	1(10)
Divorced	1(10)	5(50)
Separated	3(30)	2(20)
Number of children		
1 child	1(10)	0(0.0)
2 children	6(60)	7(77.8)
3 children	1(10)	0(0.0)
Nil	2(20)	2(22.2)
Type of family		
Nuclear	7(70)	8(80)
Joint	3(30)	2(20)
Family income per month (INR)		
Less than 5000	1(10)	1(11.1)
5000-10000	2(20)	2(22.2)
15001-20000	1(10)	1(11.1)
Above 20000	6(60)	5(55.6)
Dietary habit		
Vegetarian	3(30)	3(30)
Non –vegetarian	7(70)	7(80)
Habit of drinking milk		
yes	6(60)	3(33.3)
No	4(40)	6(66.7)
Level of house hold work		
Mild work	1(10)	0(0.0)
Moderate work	1(10)	10(100)
Heavy work	8(80)	0(0.0)
Physical activity		
yes	3(30)	5(55.6)
No	7(70)	4(44.4)
Chronic health issues		
Yes	3(30)	2(20)
No	7(70)	8(80)
Body mass index (Asian criteria-BMI)		
Normal	3(30)	3(30)
Under weight	3(30)	3(30)
Over weight	2(20)	2(20)
Obese	2(20)	2(20)

VMACON/IEC/01/2020). Before beginning data collection, informed written consent was obtained from all the participants. Confidentiality of the collected data was ensured.

RESULTS

Among experimental arm participants, majority aged 30 to 40 years (n=3, 30%), studied diploma (n=5, 50%) and most of them were home makers (n=6, 60%). In control arm, majority were daily wagers. (Table 1)

Before intervention, all the women (n=10,100%) had mildly reduced bone mineral density and post intervention, majority of the women (n=8,80%) had normal bone mineral density. Only 20% (n=2) had mildly reduced bone mineral density level. In the control group, all 10 (100%) women had mildly reduced bone mineral density before receiving health education and 16 weeks after education, 90% had mildly reduced bone mineral density and only 10% had normal bone mineral density. (Table 2)

In the experimental group, the calculated paired 't' test value -6.365 shows a statistically significant difference between the pre-test and post-test level of bone mineral density among women aged 30 – 50 years. In the control group, the calculated paired test value-1.882 shows that there is no significant difference between the pre-test and post-test level of bone mineral density among women aged 30 – 50 years. (Table 3)

Calculated independent 't' test value of -1.213 shows statistically there is no significant difference between the level of bone mineral density among women aged 30 – 50 years in the pre-test between the experimental and control group, where as in post-test findings, the calculated independent 't' test value of4.250 shows that there is a statistically significant difference between the levels of bone mineral density among women aged 30-50 years between experimental and control groups.(Table 4)

Table 2: Frequency and percentage distribution of pre-test and post-test level of bone mineral density among women aged 30 – 50 years in experimental and control group (n= 10+10)

	Experimental group	
	Pre (%)	Post (%)
Level of BMD		
Normal bone density	0 (0)	8 (80)
Mildly reduced BMD	10 (100)	2 (20)
Osteoporosis	0 (0)	0 (0)
Level of BMD		
Normal bone density	0 (0)	1 (10)
Mildly reduced BMD	10 (100)	9 (90)
Osteoporosis	0 (0)	0 (0)

BMD – Bone mineral density

Table 3: Effectiveness of intervention on level of bone mineral density among women aged 30 – 50 years in the experimental and control groups (n= 10+10)

Test	Mean	Standard deviation	Mean difference	Paired 't'	p
Bone mineral density - Experimental group					
Pre test	-1.32	0.257	-2.21	-6.365	**0.001***
Post test	0.890	0.998			
Bone mineral density - Control group					
Pre test	-1.22	0.042	-0.450	-1.882	0.092
Post test	-0.770	0.727			

*Statistically significant at 0.05 level of confidence

Table 4: Comparison of the Pre-test and post- test level of bone mineral density among women aged 30 – 50 years between the experimental and control groups (n = 10+10)

Group	BMD Mean	Sstandard deviation	Mean difference	Independent 't' Value	p
Pretest					
Experimental	-1.32	0.257	-0.10	-1.213	0.241
Control	-1.22	0.421			
Posttest					
Experimental	0.890	0.998	1.66	4.250	**0.001***
Control	-0.770	0.727			

*Statistically significant at 0.05 level of confidence, BMD – Bone Mineral Density

DISCUSSION

Before intervention, all the women (100%) had mildly reduced bone mineral density and post intervention, majority of the women (80%) had normal bone mineral density, only 20% had mildly reduced bone mineral density level. In the control group, 100% had mildly reduced bone mineral density before receiving health education and after 16 weeks of education, 90% had mildly reduced bone mineral density and only 10% had normal bone mineral density.

According to Shahnaz Akil et.al., (2021), the nulliparous women group exhibited a considerably greater prevalence of normal BMD than the multiparous group (70.6 percent vs. 47.1 percent). 51.2% of multiparous females had normal BMD, 25.6% had below-average BMD, 18.6% had osteopenia, and 4.7% had osteoporosis. Parity impacts the bone mineral density (BMD) of young and middle-aged females as compared to nulliparous females, as measured by a portable ultrasound-based bone densitometer.[17]

In experimental group, the calculated paired 't' test value of t = -6.365 shows statistical significance. In control group, the calculated paired 't' test value of t = -1.882 shows statistically there is no significant difference. Poova Ragavan, S. Ani Grace Kalaimathi, A.F. Annie Raja, and Anitha Babu (2019) found that bone mineral density was 1.92 with a standard deviation of 0.40 before the test and 1.63 with a standard deviation of 0.52 after. The calculated paired 't' value 3.339 is statistically significant at the 0.05 level. Prior to the test, the mean bone mineral density in the control group was 1.88 with a standard deviation of 0.35, while the mean result after the test was 2.23 with a standard deviation of 0.54. The estimated paired value t = 2.948 was statistically significant at the p-value is 0.05 level. The experimental group's post-test bone mineral density increased considerably after receiving the nurse interventional package.[18]

In pretest, the calculated independent 't' test value of t = -1.213 shows statistically not significant, in post-test the calculated independent 't' test value of t = 4.250 shows statistically highly significant.

In a systematic review conducted by Shea B et al, it was concluded that there is a positive effect on bone mineral density with calcium supplementation and a reduction in the trend of vertebral fractures among post-menopausal women.[19]

According to the findings of Hamid Arazi et.al. (2018), blood levels of 25OH-D and ALP significantly rose in the concurrent training-milk, concurrent training and milk groups, with a greater increase in the concurrent training-milk group (p –value is 0.05). Furthermore, the right and left hip BMD rose significantly in the concurrent training-milk and concurrent training groups, with the concurrent training-milk group increasing significantly more (p –value is 0.05). Contemporaneous training-milk and contemporaneous training also enhanced lumbar spine BMD substantially (p –value is 0.05).[20]

STRENGTHS AND LIMITATIONS

The sample size was smaller. This perspective does not intend to suggest what should or should not be done in the area, but rather to inspire further examination of the complexities, problems, and specific issues that nutrition and bone health scientists encounter on a daily basis. Indeed, more debate and broader consensus among scientists are urgently required in this field to address inherent limitations and create stronger data to support dietary recom-

mendations for optimal bone health across the lifetime. Primary prevention should begin in childhood and adolescence, and continue after menopause. Further development of educational initiatives and behavioural change programmes aimed at raising osteoporosis knowledge and improving dietary nutrient intakes is therefore required to improve osteoporosis prevention and management.

Conclusion

Nutritionally enriched supplements may be the best options for improving bone health since they reduce osteoclast activity while promoting osteoblast activity during bone formation. Ragi, wheat, flax, sesame seeds, and milk powder are all high in nutrients that have been demonstrated to increase bone mass density and reduce the risk of osteoporosis in adult women. Low calcium consumption has been associated with negative effects on bone mineral balance. Women in the experimental group got a nutritional intervention package that significantly increased their bone mineral density levels. However, risk can be lowered by leading a healthy lifestyle that includes enough quantities of dietary calcium, vitamin D, and protein, frequent weight-bearing activity, quitting smoking, and limiting alcohol use.

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