Section: Physiology

Original Research Article

INVESTIGATING THE CORRELATION BETWEEN DIETARY HABITS AND BONE MINERAL DENSITY IN POSTMENOPAUSAL WOMEN

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Received : *10/01/2024*
Received in revised form : *12/03/2024*
Accepted : *28/03/2024*

Keywords:
Bone mineral density, postmenopausal women, calcium, vitamin D, osteoporosis, dietary habits, DXA.

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DOI: 10.47009/jamp.2024.6.2.220

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (2); 1092-1095

Abstract

Background: Osteoporosis is common among postmenopausal women due to a reduction in bone mineral density (BMD) stemming from hormonal changes. Adequate consumption of calcium and vitamin D is crucial for bone health. This study investigates the relationship between dietary patterns and BMD in postmenopausal women, specifically focusing on the role of calcium and vitamin D intake. **Material and Methods:** The study included 100 postmenopausal women, aged 50 to 75, who were categorized into two groups based on their dietary intake: high-calcium and high-vitamin D intake versus low-calcium and low-vitamin D intake. Dietary data was obtained through a validated food frequency questionnaire, and BMD was measured at the lumbar spine and femoral neck using dual-energy X-ray absorptiometry (DXA). Additionally, serum calcium and 25-hydroxyvitamin D levels were assessed. **Results:** Dietary Intake: Participants in the high-calcium and high-vitamin D group consumed an average of 1,200 mg/day of calcium and 600 IU/day of vitamin D. In contrast, the low-calcium and low-vitamin D group consumed 600 mg/day of calcium and 200 IU/day of vitamin D.Bone Mineral Density: Those in the high-calcium and high-vitamin D group had significantly higher BMD at the lumbar spine (1.10 g/cm² vs. 0.95 g/cm², $p < 0.05$) and the femoral neck (0.92 g/cm² vs. 0.80 g/cm², $p < 0.05$) compared to the low-intake group. Serum Biomarkers: Higher serum calcium (9.5 mg/dL) and vitamin D (35 ng/mL) levels were recorded in the high-calcium and high-vitamin D group compared to the low-calcium and low-vitamin D group (8.8 mg/dL and 20 ng/mL, respectively).Correlation Analysis: A positive correlation was observed between a higher intake of calcium and vitamin D and increased BMD at both the lumbar spine ($r = 0.52$, $p < 0.01$) and femoral neck ($r = 0.45$, $p < 0.01$). **Conclusion:** This study establishes a clear link between higher dietary calcium and vitamin D intake and increased BMD in postmenopausal women. Ensuring adequate consumption of these nutrients is vital for reducing the risk of osteoporosis.

INTRODUCTION

Osteoporosis is a significant health concern among postmenopausal women, characterized by reduced bone mineral density (BMD) and an increased risk of fractures[1,2]. The decline in estrogen levels during menopause accelerates bone resorption, making women more susceptible to osteoporosis. BMD, commonly assessed using dual-energy X-ray absorptiometry (DXA), serves as a critical predictor of fracture risk[3,4].

Dietary intake of calcium and vitamin D plays an essential role in bone health. Calcium is vital for bone formation, while vitamin D aids calcium absorption in the intestines and helps maintain appropriate serum calcium levels[5,6]. Together, these nutrients contribute to bone mineralization and structural integrity. Inadequate intake of these nutrients can lead to compromised bone health and heightened osteoporosis risk[7]. Despite their known benefits, studies have found varying levels of calcium and vitamin D intake in the postmenopausal population, often falling below the recommended dietary allowances.

This study aims to examine the correlation between dietary habits, specifically calcium and vitamin D intake, and BMD in postmenopausal women. By comparing groups based on nutrient intake levels,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

the research seeks to provide insight into how variations in dietary habits may influence bone health outcomes, particularly at key skeletal sites like the lumbar spine and femoral neck. Understanding this relationship could help inform dietary recommendations and public health strategies to reduce osteoporosis risk among postmenopausal women.

MATERIALS AND METHODS

Study Design and Period

This cross-sectional study was conducted at Sri Venkateswara Medical College and General Hospital in Tirupati, India, from April 2023 to September 2023.

Participants:

The study recruited 100 postmenopausal women aged 50 to 75. Participants were divided into two groups based on dietary intake: high-calcium and high-vitamin D vs. low-calcium and low-vitamin D. Eligibility criteria included being postmenopausal for at least one year, with no history of secondary osteoporosis, chronic diseases affecting bone metabolism, or medications influencing BMD.

Dietary Assessment: A validated food frequency questionnaire (FFQ) was used to evaluate participants' dietary calcium and vitamin D intake. The FFQ captured data on the frequency and portion size of foods rich in these nutrients, and daily intakes were calculated.

Bone Mineral Density (BMD) Measurement: BMD was measured using dual-energy X-ray absorptiometry (DXA) at the lumbar spine (L1-L4) and femoral neck, reported in grams per square centimeter (g/cm^2).

Serum Biomarkers: Blood samples were collected to analyze serum calcium and 25-hydroxyvitamin D levels. Serum calcium was measured using an automated analyzer, and 25-hydroxyvitamin D was determined using chemiluminescence immunoassay.

Data Analysis: Statistical analysis was conducted using appropriate software. The t-test was used to compare means between the two dietary groups, and Pearson's correlation analysis assessed the association between dietary intake and BMD values. Statistical significance was set at $p < 0.05$.

Ethical Considerations: Ethical approval for the study was obtained from the institutional ethics committee at Sri Venkateswara Medical College. Informed consent was acquired from all participants before the study, ensuring confidentiality and voluntary participation.

RESULTS

The study examined the relationship between dietary habits and bone mineral density (BMD) in 100 postmenopausal women by categorizing participants based on their intake of calcium and vitamin D.

Dietary Intake Differences: Participants in the high-calcium and high-vitamin D group consumed an average of 1,200 mg/day of calcium and 600 IU/day of vitamin D, whereas those in the low-calcium and low-vitamin D group had an average daily intake of 600 mg and 200 IU, respectively (Table 1).

Bone Mineral Density (BMD): BMD values were significantly higher in the high-calcium and high-vitamin D group compared to the low-intake group at both the lumbar spine and femoral neck sites. The mean BMD at the lumbar spine was 1.10 g/cm^2 for the high-intake group and 0.95 g/cm^2 for the low-intake group. Similarly, at the femoral neck, the high-intake group exhibited a mean BMD of 0.92 g/cm^2, while the low-intake group had 0.80 g/cm^2. Both comparisons yielded statistically significant differences ($p < 0.05$, Table 2).

Serum Biomarker Analysis: Participants in the high-calcium and high-vitamin D group had higher levels of serum calcium (mean 9.5 mg/dL) and vitamin D (mean 35 ng/mL) compared to the low-intake group (serum calcium: mean 8.8 mg/dL; vitamin D: mean 20 ng/mL). These differences were consistent with their dietary intake (Table 3).

Correlation Analysis: A positive correlation was observed between higher dietary intake of calcium and vitamin D and BMD at both the lumbar spine ($r = 0.52$, $p < 0.01$) and femoral neck ($r = 0.45$, $p < 0.01$), as shown in Table 4.

Table 1: Dietary Intake Differences

Group	Calcium Intake (mg/day)	Vitamin D Intake (IU/day)
High-Calcium and High-Vitamin D	1,200 (±150)	600 (±80)
Low-Calcium and Low-Vitamin D	600 (±100)	200 (±50)

Table 2: Bone Mineral Density (BMD)

Site	High-Calcium & High-Vitamin D (g/cm^2)	Low-Calcium & Low-Vitamin D (g/cm^2)
Lumbar Spine	1.10 (±0.08)	0.95 (±0.07)
Femoral Neck	0.92 (±0.06)	0.80 (±0.05)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 3: Serum Biomarker Analysis

Group	Serum Calcium (mg/dL)	Serum Vitamin D (ng/mL)
High-Calcium and High-Vitamin D	9.5 (±0.6)	35 (±5)
Low-Calcium and Low-Vitamin D	8.8 (±0.5)	20 (±4)

Table 4: Correlation Analysis

Site	Correlation Coefficient (r)	p-value
Lumbar Spine	0.52	<0.01
Femoral Neck	0.45	<0.01

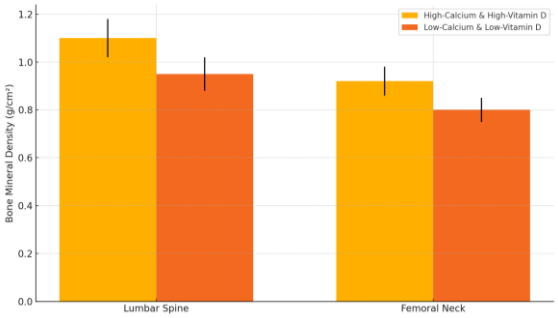

Figure No: 1 Bone Mineral Density by Nutrient Intake Group and Site

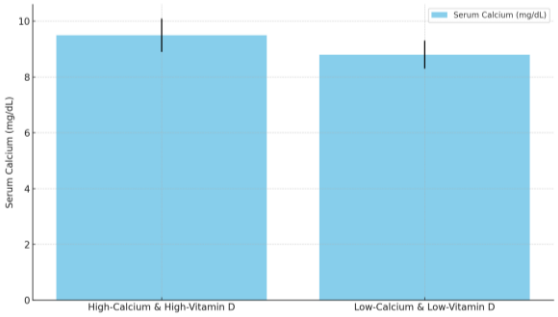

Figure No: 2 Serum Calcium Levels by Group

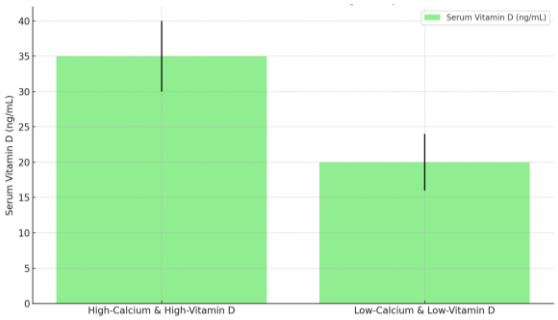

Figure No: 3 Serum Vitamin D Levels by Group

DISCUSSION

The results of this study underscore the significant role of dietary calcium and vitamin D in maintaining bone mineral density (BMD) in postmenopausal women. Women with higher dietary intake of these essential nutrients exhibited significantly greater BMD at both the lumbar spine and femoral neck compared to those with lower intake. This aligns with existing literature, which emphasizes that adequate calcium and vitamin D intake can mitigate bone loss and reduce the risk of osteoporosis[8,9].

Dietary Intake and BMD: The positive correlation observed between calcium and vitamin D intake and BMD highlights the importance of incorporating foods rich in these nutrients in the diet[10]. The high-calcium and high-vitamin D group displayed higher serum levels of both nutrients, suggesting that dietary habits directly influence biomarker concentrations and subsequent bone health[11,12]. This finding supports the hypothesis that nutritional intake plays a crucial role in maintaining bone structure, especially in postmenopausal women who experience accelerated bone loss due to reduced estrogen levels[13].

Clinical Implications: From a clinical perspective, these results emphasize the need for healthcare providers to actively promote dietary guidelines that prioritize foods high in calcium and vitamin D. This approach could help mitigate the risks of osteoporosis and fracture in aging populations, particularly among postmenopausal women[14].

Study Limitations: However, this study is not without limitations. Its cross-sectional design only provides a snapshot of the relationship between dietary habits and BMD. A longitudinal study could offer deeper insights into long-term dietary impacts. Moreover, while the food frequency questionnaire (FFQ) provided valuable dietary intake data, self-reporting can introduce bias due to inaccuracies in recalling dietary habits. Additionally, other factors influencing bone health, such as genetic predisposition and physical activity, were not fully addressed.

CONCLUSION

Despite these limitations, the study provides strong evidence linking higher dietary calcium and vitamin D intake to improved BMD in postmenopausal women. These findings highlight the importance of tailored nutritional strategies and emphasize the need for further longitudinal research to establish optimal nutrient intake guidelines for osteoporosis prevention.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556