

Original Article**EXPLORING THE EFFECTIVENESS AND SAFETY OF CALCIUM AND VITAMIN D SUPPLEMENTATION ON BONE HEALTH OF INDIAN PATIENTS: REAL-WORLD MULTICENTER RETROSPECTIVE STUDY****MADKHOLKAR NM^{1*}, PAWAR RR², SHARMA AD³****¹Medical Advisor, Alkem Laboratories, Mumbai, India. ²Deputy General Manager, Alkem Laboratories, Mumbai, India. ³Chief Medical Officer and President, Alkem Laboratories, Mumbai, India*****Corresponding author: Madkholkar NM; *Email: nishikant.madkholkar@alkem.com****Received: 14 Apr 2025, Revised and Accepted: 04 Jun 2025****ABSTRACT****Objective:** To evaluate the impact of calcium and vitamin D supplementation on bone health in osteoporotic patients.**Methods:** A multi-centric retrospective observational study was conducted on osteoporotic patients supplemented with vitamin D and calcium. Data on patient demographics, treatment history, bone health parameters (bone mineral density (BMD), fracture, muscle strength, and balance), laboratory results, and adverse events were retrospectively collected from existing medical records.**Results:** The mean BMD increased from 0.823 to 0.854 g/cm². Fracture incidence declined significantly from 15.6% to 12.1% (p<0.001). Muscle strength increased from 23.4 to 26.1 kg (p<0.001), and balance improved from 43.2 to 47.3 seconds (p<0.001). Serum calcium increased from 8.5 to 9.2 mg/dl (p<0.001), and vitamin D levels increased from 20 to 41 ng/ml (p<0.001). Most patients (91.5%) reported no adverse effects, with 8.5% experiencing gastrointestinal symptoms (nausea, vomiting, constipation, gastric irritation) in 5%.**Conclusion:** Vitamin D and calcium supplementation in osteoporotic patients significantly improved BMD, risk of fracture, muscle strength, balance, and biochemical parameters from baseline. The combined supplementation demonstrated a favorable safety profile.**Keywords:** Bone mineral density, Fracture, Balance, Muscle strength

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INTRODUCTION

Osteoporosis is a skeletal condition caused due to reduction in bone mass, presenting with a greater susceptibility to fracture. Evidence reveals that approximately 1 out of 2 women and 1 in 5 men over the age of 50 are prone to experiencing an osteoporotic fracture during their lifetime [1-3]. According to the Global Burden of Disease (GBD) 2019, India ranks highest in the number of DALYs (disability-adjusted life-years) in low bone mineral density BMD-related fracture patients, accounting for 25.59% of the total burden [4].

Calcium and vitamin D are critical elements in maintaining skeletal health. Several studies have suggested that the intake of 800 IU vitamin D supplements every day and 1200 mg of calcium supplementation prevents fractures in geriatric population, particularly those in care facilities or with inadequate serum vitamin D levels [5, 6]. While calcium and vitamin D are crucial in managing osteoporosis, it is essential to remember that these are distinct nutrients with unique roles in mineral metabolism.

Calcium, a mineral and macronutrient, is an abundant mineral constituent of the bone that is required for healthy growth, development, and restoration of the structural integrity of bone [7]. In order to maintain skeletal functions, dietary sources of calcium are preferred, but vitamin supplementation is often recommended to ensure sufficient intake in populations with inadequate dietary calcium or those at an increased risk of osteoporotic fractures [8, 9].

Vitamin D, an organic vitamin and micronutrient structurally similar to steroid hormones, serves as a precursor to calcitriol. Calcitriol is the primary hormone that modulates intestinal calcium absorption within the body [8]. Vitamin D promotes muscle and skeletal health by regulating calcium absorption and mineralization of skeletal osteoid tissue. Vitamin D deficiency may lead to secondary hyperparathyroidism, bone mass reduction, and muscular weakness [10].

The present retrospective analysis aims to evaluate the impact of calcium and vitamin D supplementation on overall health, including

bone mineral density (BMD), fracture incidence, muscle strength, and balance among Indian patients.

MATERIALS AND METHODS**Study design**

A multi-centric retrospective observational study was conducted across 248 centers in India in a cohort of patients diagnosed with osteoporosis who have received a combination of calcium and vitamin D supplements as part of their treatment. Ethical approval was obtained from the Life Point Research Ethics Committee, Pune. Informed consent from patients was waived, as the study involved anonymized retrospective data.

Study participants

The present study included patients who aged 18 y and above, have received combined supplementation of calcium and vitamin D within the past 1 y from data collection, as part of their treatment regimen and whose complete medical records were available, including demographic information, diagnosis, treatment history, laboratory results, and follow-up visits.

Patients were excluded if they had incomplete medical records, those with conditions affecting calcium and vitamin D metabolism (e. g., hyperparathyroidism, kidney failure), chronic kidney disease (CKD) stage 4 or higher and those with a history of hypercalcemia or hypercalciuria before supplementation initiation.

Outcome measures

Medical records of eligible patients were retrospectively reviewed to extract relevant data on patient characteristics and treatment outcomes.

Clinical parameters included bone health outcomes (BMD and fracture history), muscle strength and balance assessments, fall history, incidence of secondary hyperparathyroidism, and

inflammatory markers. Handgrip Strength Test and Timed Up and Go (TUG) Test was used for muscle strength and balance, respectively. Adherence to supplementation regimens was assessed. Adverse events related to supplementation and all-cause mortality rates were also recorded.

Statistical analyses

The statistical analyses were performed using SPSS software at a 95% confidence interval (CI). Descriptive statistics summarized population characteristics, providing mean and standard deviations (SD) for continuous variables, and frequencies and percentages for categorical variables. A p-value less than 0.05 was considered statistically significant.

RESULTS

Patient demographics and baseline characteristics

The study included 13,648 participants. The mean age of the population was 57.08 (SD= 11.07) y. The majority of the study population was male (59.7%, n = 8,145), while females constituted 40.3% (n = 5,503). Among the participants, 54.28% (n = 7,409) reported having co-morbidities. Bone pain was the most commonly reported symptom, affecting 44.25% (n = 6,120) of participants, followed by muscle weakness in 32.50% (n = 4,358) and muscle cramps in 18.32% (n = 2,514). Only a small proportion of participants (4.93%, n = 656) were asymptomatic.

Supplementation adherence

The duration of supplementation varied among patient groups, with 22.1% receiving it for less than 3 mo, 39.7% for 3–6 mo, and 38.2% for more than 6 mo (table 1). Adherence to the supplementation

regimen was high, with 90.8% of participants reporting good or excellent adherence.

Bone health parameters

BMD in participants significantly improved following a combined supplementation regimen (table 2). The mean BMD increased from 0.823 (SD= 0.113) g/cm² to 0.854 (SD= 0.108) g/cm², representing a statistically significant improvement (p<0.001). This positive change was observed across all age groups, with the most notable increase of 3.5% occurring in the 65–74 y age group.

A statistically significant decline in fracture incidence from 15.6% to 12.1% (p<0.001) was observed after supplementation, representing a 22.4% reduction.

Muscle strength and balance in patients increased statistically significantly following supplementation (p<0.001). An 11.6% increase in mean muscle strength was observed, with the highest gains of 12.3% reported in participants aged 65 y and older (p<0.001). A statistically significant improvement in balance (9.5%, p<0.001) was identified following supplementation.

A significant percentage (78.8%) of the patients had no history of falls, while 19.8% reported experiencing falls.

Biochemical parameters

The biochemical parameters increased significantly from the baseline after calcium and vitamin D supplementation (p<0.001) (table 2). The mean serum calcium level elevated from 8.5 (SD=0.8) mg/dl to 9.2 (SD= 0.7) mg/dl (p<0.001), and the mean vitamin D level increased from 20 (SD= 10) ng/ml to 41 (SD= 15) ng/ml (p<0.001).

Table 1: Duration and adherence to supplementation of the combined regimen

Duration of supplementation	n	%
Less than 3 mo	3012	22.1
More than 3 to 6 mo	5434	39.7
More than 6 mo	5202	38.2
Adherence to supplementation		
Excellent	3612	26.5
Good	8770	64.3
Fair	1154	8.5
Poor	112	0.8

Table 2: Changes in bone health parameters and biochemical parameters

Parameters	Pre-supplementation		Post-supplementation		P-value
	Mean	SD	Mean	SD	
BMD (g/cm ²)	0.823	0.113	0.854	0.108	0.001
Muscle Strength (kg)	23.4	5.6	26.1	5.4	0.001
Balance (s)	43.2	2.05	47.3	1.37	0.001
Serum Calcium Level (mg/dl)	8.5	0.8	9.2	0.7	0.001
Serum Vitamin D Level (ng/dl)	20	10	41	15	0.001

Adverse effects

Most of the patients did not report any adverse effects (91.5%). Only 8.50% of patients reported adverse events, with gastrointestinal symptoms (Nausea, vomiting, constipation, Gastric irritation) being the most common (5%).

DISCUSSION

The present study that included Indian patients with osteoporosis demonstrated significant improvements in bone health and biochemical parameters, including a 3.8% improvement in BMD, 22.4% reduction in fracture incidence, 11.6% improvement in muscle strength, and a 9.5% enhancement in balance following a combined supplementation regiment of calcium and vitamin D. Serum calcium and vitamin D levels improved significantly after the combined supplementation, and minimal adverse effects were reported by the patients.

Previous studies have studied calcium and vitamin D supplementations as monotherapies on bone health in osteoporotic patients, however, the literature of the combined supplementation remains largely unexplored. An RCT conducted on elderly patients reported a significant increase in total BMD (1.18%) in a high-dose vitamin D cohort (3,750 IU/day) compared to a lower-dose cohort (600 IU/day) (p<0.05) [11]. Another study including the elderly population reported a 0.06% increase in the combined supplementation group, whereas a 1.09% decrease in BMD was observed in the placebo group [12].

This study observed that the risk of fracture decreased after the combined supplementation regimen. Similar findings were reported by Yao *et al.* (2019), demonstrating a 6% reduction in the risk of fractures in patients receiving the combined supplementation for a duration of 6 y [13]. Therefore, using combined supplements may provide synergistic benefits in reducing fracture risk in osteoporotic individuals.

Following the combined supplementation regimen, significant improvements in serum vitamin D and calcium levels in osteoporotic patients similar to previous studies. In study conducted on elderly participants, administered with combined supplementation for 3 mo, an increase of 13.9 ng/ml in serum 25(OH)D levels was observed; the levels rose from 12.3 ng/ml to 26.2 ng/ml, nearly doubling the baseline vitamin D concentration [14]. Since vitamin D deficiency has major implications in developing osteoporosis, ensuring adequate supplementation constitutes a crucial aspect of overcoming the deficiency in osteoporosis management.

Post-supplementation the levels of serum calcium improved from baseline. Similarly, Feng *et al.* (2021) observed a blood calcium increase from 2.22 to 2.43 mmol/l following calcium and active vitamin D supplementation ($p < 0.05$) [15].

The large sample size strengthens the study's statistical power and applicability to clinical practice. However, the retrospective design, short supplementation period, and lack of optimal dosing guidelines limit the findings. Future RCTs are needed to establish long-term effectiveness and safe dosing strategies. Despite these limitations, the study supports the benefits of combined calcium and vitamin D supplementation for osteoporosis.

CONCLUSION

Vitamin D and calcium supplementation in osteoporotic patients significantly improves BMD, fracture risk, muscle strength, balance, and biochemical parameters, with a favorable safety profile. Future randomized clinical trials in Indian populations with fixed dosing regimens are needed to confirm these findings and establish optimal supplementation strategies for better therapeutic outcomes.

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Nil

AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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