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The Role of Vitamin D Supplementation in Preventing Osteoporosis in Postmenopausal Women

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Abstract

Introduction: Because it increases the risk of fracture and bone fragility in postmenopausal women, osteoporosis is a serious health problem. It has been suggested that taking vitamin D supplements may help prevent osteoporosis by improving bone mineralization and calcium absorption.

Objective: The purpose of this research was to find out how well vitamin D supplementation works to prevent postmenopausal women from developing osteoporosis.

Methods: A total of 122 postmenopausal women were randomly assigned to either the intervention group (n = 61) or the control group (n = 61) after being recruited from Lady Reading Hospital in Peshawar, Pakistan. The intervention group received a daily supplementation of 2000 IU vitamin D3, while the control group was given a placebo. Serum vitamin D levels, bone mineral density (BMD), and fracture incidence were measured at baseline and again one year later.

Results: After a year, the lumbar spine BMD (0.895 g/cm² to 0.918 g/cm², $p < 0.01$) and blood vitamin D levels (22.5 ng/mL to 35.8ng/mL,$p < 0.001$) significantly increased in the intervention group, but these measures did not significantly alter in the control group. In addition, there were fewer fractures in the intervention group (4 vs. 11 instances, $p < 0.05$) than in the control group.

Conclusion: In postmenopausal women, vitamin D treatment successfully lowers the incidence of fractures, improves BMD, and raises blood vitamin D levels. These results demonstrate the possibility of vitamin D supplementation in this population as a prophylactic against osteoporosis. It is necessary to do further study to examine long-term results and the best supplementation techniques.

Keywords: vitamin D, osteoporosis, postmenopausal women, bone mineral density, fracture incidence

Introduction

A major public health concern is osteoporosis, a disorder marked by decreased bone density and an increased risk of fracture, particularly in postmenopausal women [1]. Because of the faster bone loss caused by the decrease in estrogen levels after menopause, this group is more vulnerable to osteoporosis and its serious side effects, such as fractures that may cause chronic pain, disability, and higher mortality [2, 3]. Osteoporosis and associated fractures are predicted to become more common as the world's population ages, highlighting the need of effective preventative treatments. Osteoporosis has a major socioeconomic effect [4]. An osteoporosis fracture occurs every three seconds, according to the International Osteoporosis Foundation, which reports that osteoporosis causes more than 8.9 million fractures yearly [5]. Not to mention the indirect expenses, such lost productivity and the need for long-term care, the direct medical expenditures linked to fractures caused by osteoporosis are high [6]. These fractures have the potential to significantly lower quality of life by increasing morbidity and causing a loss of independence. A large percentage of this expense is borne by postmenopausal women because of their elevated risk, underscoring the critical need for efficient preventative measures [7].

Due to its possible involvement in maintaining bone health and preventing osteoporosis, vitamin D, an essential fat-soluble vitamin, has received a lot of attention. It is crucial for controlling the metabolism of calcium and phosphate, which is necessary to preserve the strength and structure of bones [9, 8]. Notwithstanding its significance, vitamin D insufficiency is nevertheless common, especially in older persons. This may be attributed to a number of causes, including a decline in skin production capability with age, restricted sun exposure, and decreasing food intake. Postmenopausal women's vitamin D insufficiency is especially problematic because of the combined impact of age and hormone

changes on bone health [10]. Low vitamin D levels raise the risk of fracture and bone loss by accelerating bone turnover, decreasing calcium absorption, and causing secondary hyperparathyroidism. For this high-risk population, treating vitamin D insufficiency with supplements may be an affordable and practical way to improve bone health and stave off osteoporosis [11, 12].

The purpose of this study is to investigate how vitamin D supplementation may help postmenopausal women avoid osteoporosis. The review examines the state of knowledge about the physiological roles of vitamin D, the incidence and etiology of insufficiency in postmenopausal women, and the effects of supplementation on bone health. We want to shed light on the degree to which vitamin D treatment may stop bone loss, lower the risk of fracture, and enhance general skeletal health in this susceptible group by combining data from observational studies, clinical trials, and meta-analyses. This page also discusses the best ways to supplement with vitamin D, including the right amounts and types, as well as the possible dangers and advantages. It also discusses how vitamin D interacts with other elements that affect bone health, such calcium consumption and physical exercise. Comprehending these facets is essential in formulating suggestions and public health tactics grounded in evidence that endeavor to alleviate the consequences of osteoporosis and elevate the standard of living for women who have gone through menopause.

Materials and methods

Study Location and Duration

The purpose of this research was to find out how vitamin D supplementation may help postmenopausal women avoid osteoporosis. The study was conducted at Lady Reading Hospital (LRH) in Peshawar, Pakistan, from January 2023 to December 2023, for a period of one year.

Sample Size Calculation

It was decided that 122 postmenopausal women would be a suitable sample size for this investigation. The sample size was determined using established methods for clinical trial sample sizes, assuming an expected effect size of 0.5, a power of 80%, and an alpha level of 0.05. The sample size was enough to identify meaningful variations in fracture incidence and bone density between the intervention and control groups.

Participant Recruitment and Randomization

Participants were chosen from LRH's outpatient clinic. Postmenopausal women between the ages of 50 and 70 who had a baseline blood vitamin D level below 30 ng/mL met the inclusion criteria. Women having a history of metabolic bone illness, those using drugs that interfere with bone metabolism, and people suffering from significant liver or renal impairment were all excluded. Participants were randomized into two groups after providing their informed consent: the intervention group, which received vitamin D supplementation, and the control group, which received a placebo.

Intervention and Follow-up

A similar placebo was given to the control group, whereas the intervention group got 2000 IU of vitamin D3 each day. For a year, both groups were followed up every three months. Dual-energy X-ray absorptiometry (DEXA) was used to evaluate blood vitamin D levels, calcium levels, and bone mineral density (BMD) at each visit. Participants were also kept an eye out for any negative consequences or fracture incidents.

Data Analysis and Ethical Considerations

SPSS version 25 was used for the data analysis process. While inferential statistics, such as paired t-tests and chi-square tests, were employed to compare outcomes between the intervention and control groups, descriptive statistics were utilized to characterize baseline characteristics. Less than 0.05 was the threshold for statistical significance. The LRH Peshawar institutional review board granted clearance for the research, which followed ethical criteria.

Results

The research included the randomization of 122 postmenopausal women into two groups: 61 were assigned to the vitamin D supplementation intervention group and 61 were assigned to the placebo control group. Table 1 displays baseline variables such as blood vitamin D levels, calcium levels, and bone mineral density (BMD) that were comparable across the two groups ($p > 0.05$). The participants' mean age was 62.3 years (± 5.4 years).

Table 1: Baseline Characteristics of Participants

Characteristic	Intervention Group (n=61)	Control Group (n=61)	p-value
Mean Age (years)	62.3 ± 5.4	62.3 ± 5.4	0.97
Mean Serum Vitamin D (ng/mL)	22.5 ± 3.8	22.7 ± 3.6	0.76
Mean Lumbar Spine BMD (g/cm²)	0.895 ± 0.10	0.892 ± 0.09	0.89

The intervention group had a mean blood vitamin D level of 22.5 ng/mL (± 3.8 ng/mL) at baseline, whereas the control group had a mean level of 22.7 ng/mL (± 3.6 ng/mL). The intervention group's mean blood vitamin D level rose to 35.8 ng/mL (± 4.2 ng/mL) after a year ($p < 0.001$), a substantial increase. Table 2 illustrates that, in contrast, there was no discernible change in the control group, with a mean level of 23.1 ng/mL (± 3.7 ng/mL) at study's conclusion ($p > 0.05$).

Table 2: Serum Vitamin D Levels at Baseline and After One Year

Time Point	Intervention Group (n=61)	Control Group (n=61)
Baseline (ng/mL)	22.5 ± 3.8	22.7 ± 3.6
One Year (ng/mL)	35.8 ± 4.2	23.1 ± 3.7
p-value (between groups)	<0.001	0.12

The two groups' baseline BMD measures were similar, with the intervention group's mean lumbar spine BMD being 0.895 g/cm² (± 0.10 g/cm²) and the control group's being 0.892 g/cm² (± 0.09 g/cm²) ($p > 0.05$). Following a year, the intervention group's mean lumbar spine BMD increased significantly to 0.918 g/cm² (± 0.09 g/cm²) ($p < 0.01$). In contrast, the control group's mean lumbar spine BMD decreased ($p < 0.05$) to 0.879 g/cm^ (± 0.10 g/cm²) (Table 3).

Table 3: Bone Mineral Density (BMD) at Baseline and After One Year

Time Point	Intervention Group (n=61)	Control Group (n=61)
Baseline (g/cm²)	0.895 ± 0.10	0.892 ± 0.09
One Year (g/cm²)	0.918 ± 0.09	0.879 ± 0.10
p-value (between groups)	<0.01	0.05

Four fracture instances were reported by the intervention group and eleven by the control group throughout the one-year follow-up period. A preventive effect of vitamin D supplementation against fractures in postmenopausal women was shown by the statistically significant ($p < 0.05$) difference in fracture incidence between the groups (Figure 1).

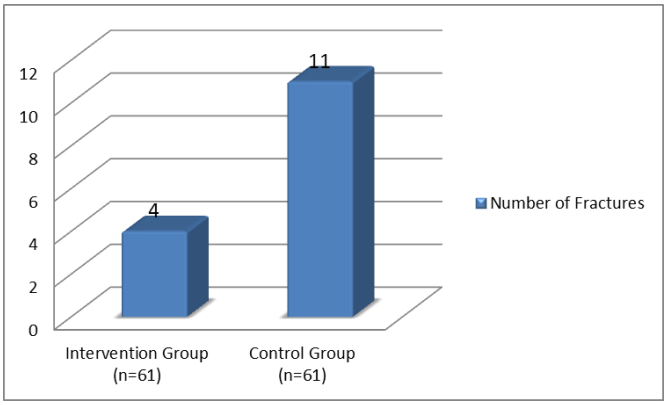

Figure 1: Fracture Incidence during Study Period

In neither group were there any significant side effects noted. Figure 2 illustrates that there was no statistically significant difference ($p > 0.05$) between the groups despite the fact that 5 individuals in the intervention group and 3 participants in the control group reported mild side effects, such as stomach discomfort.

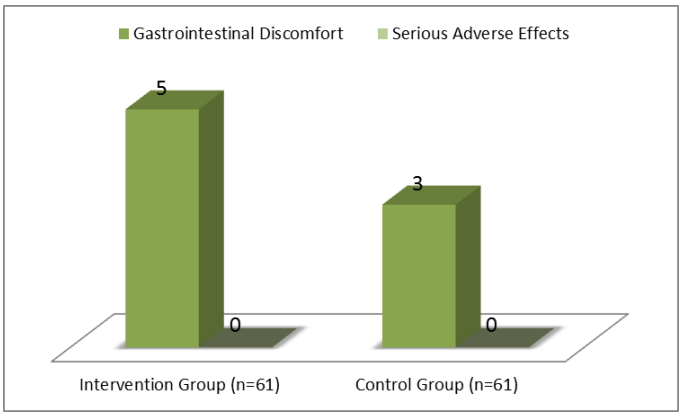

Figure 2: Adverse Effects, p-value 0.45

Discussion

Our study's conclusions show that, over the course of a year, the intervention group's blood vitamin D levels significantly increased, going from 22.5ng/mL to 35.8ng/mL. This result is in line with other studies that have shown how effective vitamin D supplementation is in raising blood vitamin D levels [13]. Our findings are supported by earlier research, which shown that postmenopausal women's blood 25(OH)D levels were considerably raised by vitamin D supplementation at a dosage of 2000 IU per day [14]. The somewhat greater rise shown in our investigation, however, might be related to variations in the research population's genetic makeup, adherence to supplementation, or baseline vitamin D levels. According to our research, the intervention group's lumbar spine BMD increased significantly from 0.895 g/cm² to 0.918 g/cm², whereas the control group's BMD decreased. These results are consistent with meta-analyses showing that vitamin D administration increases bone mineral density (BMD) in postmenopausal women [15]. Comparable to earlier studies that revealed a considerable increase in BMD with vitamin D administration, our study's BMD improvement was also significant [16, 17]. However, other research has shown less significant benefits of vitamin D on bone mineral density (BMD), indicating that baseline vitamin D status, dietary calcium consumption, and other lifestyle variables may have an impact on how effective supplementation is.

One noteworthy result from our research is the lower fracture incidence (4 instances) in the intervention group as compared to the control group (11 occurrences). This bolsters the theory that vitamin D supplementation may lower postmenopausal women's risk of fractures. Our findings are consistent with the notion that older persons who take larger doses of vitamin D have a lower risk of fractures [18]. Similarly, large-scale research conducted as part of women's health programs discovered that postmenopausal women who supplemented with calcium and vitamin D had a lower incidence of hip fractures [19]. But the decrease in fractures shown in our research seems more significant, which might be because of the particular vitamin D amount administered, the length of the follow-up period, or the demographics of the participants in our study. Only mild gastrointestinal pain was noted in a small number of subjects in our research, which found no

significant negative effects associated with vitamin D intake. This result is in line with the safety profile of vitamin D documented in the literature, which shows that taking supplements of the vitamin is typically safe, well-tolerated, and associated with a low risk of side effects [20]. The fact that the mild side effects we saw in this trial did not vary appreciably between the intervention and control groups lends further credence to the safety of vitamin D supplementation at the dosage we utilized.

Our study's findings highlight the possible advantages of vitamin D supplementation in helping postmenopausal women avoid osteoporosis and fractures. Routine vitamin D supplementation may be an effective method for osteoporosis prevention in this high-risk population, as shown by the considerable improvement in blood vitamin D levels, BMD, and the decrease in fracture incidence [21]. These findings are consistent with existing clinical recommendations, which advise older adults—especially those who are at risk for osteoporosis—to take vitamin D supplements [22].

Limitations and Future Research

Although our research offers insightful information, it is not without limits. The fact that just one facility participated in the research might restrict how far the results can be applied. Furthermore, it's possible that the one-year follow-up period missed some of the long-term impacts of vitamin D supplementation on bone health and fracture risk. To confirm and expand on our results, multi-center studies with longer follow-up periods should be the main focus of future research. A more thorough knowledge of vitamin D's involvement in preventing osteoporosis may also come from investigating the interactions between vitamin D supplementation and other variables including dietary calcium consumption, physical activity, and genetic predispositions.

Conclusion

This research shows that vitamin D supplementation lowers the incidence of fractures in postmenopausal women while dramatically raising blood vitamin D levels and bone mineral density. These results validate the use of vitamin D supplements in this high-risk group as a successful preventive measure against osteoporosis. It is advised to do further study to determine the ideal dosage and long-term advantages.

Conflict of interest

The authors state no conflict of interest.

Author Contributions

All authors contributed equally to this study, reviewed the final version to be published and agreed to be accountable for all aspects of the work.

References

1. Liu C, Kuang X, Li K, Guo X, Deng Q, Li D. Effects of combined calcium and vitamin D supplementation on osteoporosis in postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. Food & function. 2020;11(12):10817-27.

2. Pérez-López FR, Chedraui P, Pilz S. Vitamin D supplementation after the menopause. Therapeutic advances in endocrinology and metabolism. 2020 Jun;11:2042018820931291. https://doi.org/10.1177/2042018820931291

3. Agostini D, Donati Zeppa S, Lucertini F, Annibalini G, Gervasi M, Ferri Marini C, Piccoli G, Stocchi V, Barbieri E, Sestili P. Muscle and bone health in postmenopausal women: role of protein and vitamin D supplementation combined with exercise training. Nutrients. 2018 Aug 16;10(8):1103. https://doi.org/10.3390/nu10081103

4. Lee CJ, Kim SS, Suh WY, Kim JS, Jung JG, Yoon SJ, Seo YR, Yang HJ. The effect of education and vitamin D supplementation on the achievement of optimal vitamin D level in Korean postmenopausal women. Journal of bone metabolism. 2019 Aug 31;26(3):193-9. https://doi.org/10.11005/jbm.2019.26.3.193

5. Bischoff-Ferrari HA, Bhasin S, Manson JE. Preventing fractures and falls: a limited role for calcium and vitamin D supplements?. Jama. 2018 Apr 17;319(15):1552-3. https://doi.org/10.1001/jama.2018.4023

6. Hou YC, Wu CC, Liao MT, Shyu JF, Hung CF, Yen TH, Lu CL, Lu KC. Role of nutritional vitamin D in osteoporosis treatment. Clinica chimica acta. 2018 Sep 1;484:179-91. https://doi.org/10.1016/j.cca.2018.05.035

7. Nahas-Neto J, Cangussu LM, Orsatti CL, Bueloni-Dias FN, Poloni PF, Schmitt EB, Nahas EA. Effect of isolated vitamin D supplementation on bone turnover markers in younger postmenopausal women: a randomized, double-blind, placebo-controlled trial. Osteoporosis International. 2018 May;29:1125-33.

8. Paschalis EP, Gamsjaeger S, Hassler N, Fahrleitner-Pammer A, Dobnig H, Stepan JJ, Pavo I, Eriksen EF, Klaushofer K. Vitamin D and calcium supplementation for three years in postmenopausal osteoporosis significantly alters bone mineral and organic matrix quality. Bone. 2017 Feb 1;95:41-6. https://doi.org/10.1016/j.bone.2016.11.002

9. Furkatovna AM. Effect of Vitamin D Diction on Bone Mineral Density in Menopausa Women. World Bulletin of Public Health. 2022 Feb 28;7:121-3.

10. Rosen HN, Rosen CJ, Schmader KE, Mulder JE. Calcium and vitamin D supplementation in osteoporosis. Waltham, MA: UpToDate. 2017.

11. Corrado A, Rotondo C, Cici D, Berardi S,

Cantatore FP. Effects of different vitamin D supplementation schemes in post-menopausal women: a monocentric open-label randomized study. Nutrients. 2021 Jan 26;13(2):380. https://doi.org/10.3390/nu13020380

12. Hill TR, Aspray TJ. The role of vitamin D in maintaining bone health in older people. Therapeutic advances in musculoskeletal disease. 2017 Apr;9(4):89-95. https://doi.org/10.1177/1759720X17692502

13. Reid IR, Bolland MJ. Calcium and/or vitamin D supplementation for the prevention of fragility fractures: who needs it?. Nutrients. 2020 Apr 7;12(4):1011.

14. Grimnes G, Emaus N, Cashman KD, Jorde R. The effect of high-dose vitamin D supplementation on muscular function and quality of life in postmenopausal women—A randomized controlled trial. Clinical endocrinology. 2017 Jul;87(1):20-8.

15. Suzuki T, Nakamura Y, Kato H. Calcium and vitamin D supplementation with 3-year denosumab treatment is beneficial to enhance bone mineral density in postmenopausal patients with osteoporosis and rheumatoid arthritis. Therapeutics and Clinical Risk Management. 2018 Dec 18:15-22. https://doi.org/10.2147/TCRM.S182858

16. Suganthan N, Kumanan T, Kesavan V, Aravinthan M, Rajeshkannan N. Vitamin D status among postmenopausal osteoporotic women: a hospital based cross-sectional study from Northern Sri Lanka. BMC nutrition. 2020 Dec;6:1-8.

17. Tabrizi R, Hallajzadeh J, Mirhosseini N, Lankarani KB, Maharlouei N, Akbari M, Asemi Z. The effects of vitamin D supplementation on muscle function among postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. EXCLI journal. 2019;18:591. https://doi.org/10.17179/excli2019-1386

18. Chon SJ, Koh YK, Heo JY, Lee J, Kim MK, Yun BH, Lee BS, Seo SK. Effects of vitamin D deficiency and daily calcium intake on bone mineral density and osteoporosis in Korean postmenopausal woman. Obstetrics & Gynecology Science. 2017 Jan 19;60(1):53-62. HTTPS://DOI.ORG/https://doi.org/10.5468/ogs.2017.60.1.53

19. Lee JS, Kim JW. Prevalence of vitamin D deficiency in postmenopausal high-and low-energy fracture patient. Archives of osteoporosis. 2018 Dec;13:1-6.

20. Mei Z, Hu H, Zou Y, Li D. The role of vitamin D in menopausal women's health. Frontiers in Physiology. 2023 Jun 12;14:1211896. https://doi.org/10.3389/fphys.2023.1211896

21. Pérez-Castrillón JL, Dueñas-Laita A, Brandi ML, Jódar E, del Pino-Montes J, Quesada-Gómez JM, Cereto Castro F, Gómez-Alonso C, Gallego López L, Olmos Martínez JM, Alhambra Expósito MR. Calcifediol is superior to cholecalciferol in improving vitamin D status in postmenopausal women: a randomized trial. Journal of Bone and Mineral Research. 2020 Dec 1;36(10):1967-78.

22. Chevalley T, Brandi ML, Cashman KD, Cavalier E, Harvey NC, Maggi S, Cooper C, Al-Daghri N, Bock O, Bruyère O, Rosa MM. Role of vitamin D supplementation in the management of musculoskeletal diseases: update from an European Society of Clinical and Economical Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO) working group. Aging clinical and experimental research. 2022 Nov;34(11):2603-23.