ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 22(10): 6610-6614 (2026)

©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 22(10)

Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026

DOI: 10.6026/973206300226610

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Vini Mehta
E-mail: vmehta@statsense.in
Citation: Singh *et al*. Bioinformation 22(10): 6610-6614 (2026)

Prevalence of vitamin D deficiency among patients presenting with osteoporotic fractures in a tertiary care hospital in India

Niraj Narain Singh, Rakesh Kumar* & Quamrul Hoda

Department of Orthopaedics, ESIC Medical College and Hospital, Bihta, Patna, Bihar, India; *Corresponding author

Affiliation URL:
https://bihtahospital.esic.gov.in/esichospital-orthopaedics

Author contact:
Niraj Narain Singh - E-mail: drnirajnrsingh@gmail.com
Rakesh Kumar - E-mail: rakeshmsrmc@gmail.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 6610-6614 (2026)
©Biomedical Informatics (2026)

Quamrul Hoda - E-mail: quamrulhoda2020@gmail.com

Abstract:
Vitamin D deficiency is a major modifiable risk factor for osteoporosis and fragility fractures, yet its prevalence and clinical determinants among patients with osteoporotic fractures remain inadequately characterized. This prospective observational study enrolled 100 patients aged ≥ 50 years with radiologically confirmed osteoporotic fractures and assessed demographic, clinical, biochemical and serum 25-hydroxyvitamin D levels, with deficiency defined as <20 ng/mL. The mean age was 69.4±8.7 years, 68% were female and 72% had vitamin D deficiency, while hip fracture was significantly associated with deficiency (p=0.021); age ≥70 years, low dietary calcium intake, previous fragility fracture, low body mass index and limited sunlight exposure were independently associated with deficiency. The high burden of vitamin D deficiency highlights the influence of nutritional, lifestyle and clinical factors among patients with osteoporotic fractures. These findings advance knowledge by identifying modifiable predictors of vitamin D deficiency and supporting targeted screening and preventive strategies among high-risk patients.

Keywords: Osteoporosis, osteoporotic fracture, vitamin D deficiency, fracture, 25-hydroxyvitamin D, bone health

Background:
Osteoporosis is a systemic, chronic disorder of bone that is associated with a decrease in bone mass, a loss of bone structure and a decrease in bone quality and strength leading to fragility fractures. These fractures tend to occur after a fall or minor trauma and are frequently found in the hip, vertebrae, distal radius and proximal humerus **[1]**. Osteoporosis is an important public health problem globally and is a leading cause of disability and loss of independence, extended hospitalization and death in older people, especially those living in rural populations **[2]**. The ageing of the population and increased life expectancy have also been a factor in the rate of occurrence of osteoporotic fractures, further highlighting the importance of early detection and prevention of those factors **[3].** Vitamin D is closely involved with the skeleton and involves the regulation of calcium and phosphorous metabolism, calcium absorption in the intestine, bone mineralization and normal muscle function. Vitamin D deficiency contributes to worsening calcium absorption and to secondary hyperparathyroidism, increasing the rate of bone resorption, reducing bone mineral density, muscle weakness and increasing the risk of falling and fragility fracture incidence **[4]**. The fact that vitamin D deficiency could be termed a global health issue relevant to people of all ages and geographical locations, including in sunny, tropical nations, raised the matter regarding bone health and the prevention of fractures **[3].** Further progress has shown that vitamin D has many skeletal and extra skeletal activities owing to its high levels of expression of vitamin D receptors in various tissues. Vitamin D also plays a role in maintaining bone integrity and in regulating muscles, the immune system, inflammation and fracture healing **[5]**. In addition to the maintenance of bone strength, Bouillon *et al.* discussed the importance of depletion therapy with vitamin D in order to avoid complications concerning the musculoskeletal system related to osteoporosis **[6].** These ideas were reinforced by the Second International Conference on Controversies in Vitamin D, which agreed that vitamin D deficiency is a very common condition worldwide and should be diagnosed, supplemented and monitored using standard definitions and doses in at-risk groups **[7, 8].** Many tropical countries have sufficient levels of sunlight and yet an adequate level of vitamin D deficiency is consistently high, with various possible reasons for this, including aging, the lack of vitamin D in our diets, darker skin pigmentation, low levels of vitamin D in the blood, chronic illnesses and a lack of sun exposure due to urban lifestyle or lack of movement. Amrein *et al.* called it "Vitamin D deficiency 2.0" because hypovitaminosis D continues to afflict a significant minority of the world's population and to be an important risk factor for osteoporosis and fragility fractures **[9].** Osteoporosis is a significant risk factor for vitamin D deficiency, leading to increased fracture risk, slower functional recovery and poor long-term musculoskeletal outcomes. Vitamin D's role has come to light and guidelines for treating clinical vitamin D deficiency have been revised to include a more frequent evaluation of vitamin D status in persons with osteoporosis. According to the Endocrine Society's clinical practice guideline, vitamin D deficiency should be evaluated and corrected as part of the treatment for osteoporosis, especially in postmenopausal women and in elderly people with a high fracture risk **[10].** Vitamin D has recently been emphasized in comprehensive fracture care in the orthopedic literature due to its potentially beneficial action in fracture healing and its effects on immune modulation, reduction in post-operative complications and recovery of functions after orthopedic trauma **[11].** There are current international guidelines stressing the importance of systematic assessment and vitamin D replacement therapy in patients with fragility fractures. Assessment of vitamin D status, adequate calcium intake, lifestyle modification and pharmacologic treatment for vitamin D deficiency to prevent recurrent fractures and to improve long-term outcomes of patients with osteoporosis are recommended by the National Osteoporosis Guideline Group (NOGG) 2024 top five recommendations **[12].** Therefore, it is of interest to evaluate the prevalence of vitamin D deficiency among the patients who were brought with osteoporotic fractures to a tertiary care hospital and its association with some demographic and clinical parameters.

Materials and Methods:
Study design and setting:
The proposed work was a Prospective observation based study in Department of Orthopaedics, Tertiary care teaching hospitals, with the approval of the institutional Ethics Committee.

Study duration and population:
It lasted about 18 months and involved adult patients who presented at the outpatient department, emergency department or in-patient wards having a radiologically confirmed osteoporotic (fragility) fracture.

Sample size:
Patients were enrolled by consecutive sampling with a total of 100.

Inclusion criteria:
[1] Patients aged ≥50 years.
[2] Radiologically confirmed osteoporotic fracture by low energy fracture trauma.
[3] Fractures that are diagnosed less than 14 days after an injury or fall.
[4] Inform written consent given.

Exclusion criteria:
Patients with high energy trauma, pathological fracture secondary to malignancy, chronic liver disease (CLD), chronic kidney disease (stage IV/V), long-term corticosteroid therapy (>3 months), high dose vitamin D supplementation (within the previous 3 months), metabolic bone disease other than osteoporosis and those who refused to participate in the study were excluded.

Data collection:
Data on demographics (age, gender, residence, BMI, occupation, Socioeconomic status), clinical features such as type of fractures, previous fragility fractures, physical activity, dietary calcium intake, menopausal status, laboratory tests and radiological features were documented on a pre-designed case record form and were also recorded for smokers and alcohol consumers.

Laboratory and radiological evaluation:
Laboratory tests performed consisted of serum 25-hydroxyvitamin D [25(OH)D] levels, calcium levels, phosphorus levels, alkaline phosphatase, albumin level, complete blood count, random blood sugar leveland parathyroid hormone, as appropriate. All fractures were taken on standard x-rays in both the anteroposterior and lateral views and bone mineral density (DEXA) reports were taken if available.

Assessment of vitamin D status:
Serum 25(OH)D was measured by a standardized chemiluminescent immunoassay and designated deficient (<20 ng/mL), insufficient (20–29 ng/mL) and sufficient (≥30 ng/mL).

Outcome measures:
Vitamin D deficiency was the main outcome examined in the patients with osteoporotic fractures. Secondary outcomes were the associations with age, sex, fracture type, BMI, exposure to sunlight, dietary calcium intake, prior fragility fractures and selected biochemical parameters.

Statistical analysis:
The data were entered in Microsoft Excel programs and analyzed in IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are displayed in mean ± standard deviation or median (IQR) and categorical variables' findings are presented in frequencies and percentages. The Chi-square test or Fisher's exact test was used for categorical data and the independent Student's t-test or Mann–Whitney U-test was used for continuous data, as appropriate, to display the association. Logistic regression analysis was run with only D factors retained in the model after excluding the non-significant independent variables to determine the independent factors associated with low vitamin D levels. A p value was deemed significant for <0.05.

Results:
The present study is a prospective observational study of 100 patients with radiologically confirmed osteoporotic (fragility) fractures. All the enrolled participants were clinically evaluated, subjected to biochemical investigations and plasma estimation of 25-hydroxy vitamin D. The prevalence of vitamin D deficiency and the relations with demographic and clinical parameters were analysed. Multivariable logistic regression was then re-run against the variables found to be clinically relevant to visualize which variables were independent predictors of vitamin D status. Among the 100 study participants, the majority (36%) of the participants belonged to the 70–79 year-old age group, followed by 60–69-year-olds making up 31%. 68% of the study population were female. Overall, it was found that 72% of all the patients were vitamin D deficient and only 8% had adequate vitamin D levels. The age was statistically significant with vitamin D deficiency (p=0.018); on the other hand, the distribution of gender did not show a statistically significant association (p=0.094) **(Table 1).** The highest percentages of osteoporotic fractures (45%) were in women with a hip fracture; 77.8% of whom had vitamin D deficiency. Deficiency was also extremely prevalent for vertebral fractures (69.2%). Vitamin D status was associated with fracture type as statistically significant (p=0.021), suggesting that skeletal fractures involving large bone stresses may be more prevalent in those that were vitamin D deficient **(Table 2).** The bivariate frequency of inadequate sunlight exposure, low dietary calcium intake, previous fragility fracture and low BMI were significantly elevated in patients with vitamin D deficiency vs. non-deficiency patients (all P<0.05). There were no statistically significant relationships between diabetes mellitus or hypertension and vitamin D deficiency **(Table 3).** Multivariate logistic regression identified, poor sunlight exposure exhibited the highest associated odds ratio (AOR=4.87; 95% CI: 2.01–11.82; p<0.001) for being vitamin D deficient. Those aged ≥70 years were nearly 2.5 times more likely to be vitamin D deficient compared to the younger (AOR=2.48; p=0.024). Previous fragility fracture (AOR=2.43; p=0.047) was also independently associated with vitamin D deficiency along with low BMI (AOR=2.31; p=0.041) and inadequate dietary calcium (AOR=2.94; p=0.010) intake. Females compared to males were found to have higher odds of

advancing into state of deficit (AOR=1.52), however it was not statistically significant (p=0.319) **(Table 4).**

Table 1: Demographic characteristics and serum vitamin d status of the study population (n = 100)

Variable	Number	Percentage (%)	p value
Age Group			**0.018***
50–59 years	18	18.0	
60–69 years	31	31.0	
70–79 years	36	36.0	
≥80 years	15	15.0	
Gender			0.094
Male	32	32.0	
Female	68	68.0	
Vitamin D Status			
Deficient (<20 ng/mL)	72	72.0	
Insufficient (20–29 ng/mL)	20	20.0	
Sufficient (≥30 ng/mL)	8	8.0	
Mean age (years)	69.4 ± 8.7	—	
Mean serum 25(OH)D (ng/mL)	17.9 ± 6.4	—	

Table 2: Distribution of vitamin D status according to osteoporotic fracture type

Fracture Type	Deficient	Insufficient	Sufficient	Total	p value
Hip fracture	35	7	3	45	
Vertebral fracture	18	6	2	26	
Distal radius fracture	11	4	2	17	
Proximal humerus fracture	8	3	1	12	
Total	**72**	**20**	**8**	**100**	**0.021***

Table 3: Association between clinical variables and vitamin D deficiency

Clinical Variable	Vitamin D Deficient (n=72)	Non-deficient (n=28)	p value
Poor sunlight exposure	54 (75.0%)	11 (39.3%)	<0.001*
Low dietary calcium intake	49 (68.1%)	10 (35.7%)	0.004*
Previous fragility fracture	24 (33.3%)	4 (14.3%)	0.048*
BMI <22 kg/m²	38 (52.8%)	8 (28.6%)	0.031*
Diabetes mellitus	21 (29.2%)	6 (21.4%)	0.421
Hypertension	33 (45.8%)	11 (39.3%)	0.548

Table 4: Multivariable logistic regression analysis for independent predictors of vitamin D deficiency

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p value
Age ≥70 years	2.48	1.12–5.51	0.024*
Female sex	1.52	0.66–3.47	0.319
BMI <22 kg/m²	2.31	1.03–5.16	0.041*
Poor sunlight exposure	4.87	2.01–11.82	<0.001*
Low dietary calcium intake	2.94	1.29–6.71	0.010*
Previous fragility fracture	2.43	1.01–5.86	0.047*

Discussion:

The frequency of vitamin D deficiency patients with osteoporotic fracture was high in the present study and 72% of the patients had serum 25 (OH) D levels less than 20 ng/mL, while 20% of them had vitamin D insufficiency. Therefore, the prevalence of hypovitaminosis D and fragility fracture were very close, with almost 92% of the study population having sub-optimal vitamin D status. In vitamin D deficiency, calcium levels are disturbed leading to disturbances of bone mineralization, muscle strength and balance, with an elevated fall and fracture risk. These results correspond to available international guidelines that recommend taking routine biochemical evaluation for vitamin D levels in osteoporosis care patients with fragility fracture **[13, 14].** Agarwal *et al.* reported vitamin D deficiency in 51.66% and vitamin D insufficiency in 30% of elderly patients presenting with fractures in Assam, with 81.66% having suboptimal vitamin D status. The higher prevalence observed in the present study may reflect differences in patient characteristics, fracture profile and study setting **[15]**. Most of participants in the present study were aged 70–79 years and age ≥ 70 years was an independent predictor of vitamin D deficiency (AOR = 2.48, p = 0.024) when adjusted for the other variables. Increased age is linked to a decrease in vitamin D production in skin, in the ability of kidneys to activate it, a decline in its consumption in the diet and a decrease in calcium absorption, all these factors increase osteoporosis and fracture risk with age. The results are in line with the new Taiwan clinical practice guideline that suggests routine measurement of serum vitamin D should be performed in elderly patients as age is among the most important risk factors for fragility fractures **[16].** Dietary calcium deficiency significantly was related with Vitamin D deficiency and it was an independent factor in multivariable analysis (AOR: 2.94, p: 0.010). Patients with previous fragility fracture also showed significantly increased risk of vitamin D deficiency (AOR = 2.43, p = 0.047), which suggests continued suboptimal bone metabolism and secondary fracture prevention. It is recommended that good calcium provides and vitamin D supplementations are the basis for the prevention and treatment of osteoporosis, while Qaseem *et al.,* Ek *et al.* and Dakkak *et al.* mentioned the lack of use of osteoporosis therapy after fragility fracture is continuing **[14, 17 and 18].** The most frequent osteoporotic fractures were hip fractures (45%) and the majority of patients with hip fracture were deficient in vitamin D (nearly 78%). Similarly, Raj *et al.* reported a 68.3% prevalence of vitamin D deficiency among 120 patients with osteoporotic hip fractures, with deficiency being more common among older patients and a significant association between advancing age and vitamin D deficiency (p<0.05) **[19]**. These findings further support the importance of vitamin D assessment among elderly patients presenting with osteoporotic fractures. A strong correlation between fracture type and vitamin D status was found which indicates that fractures at weight bearing skeletal sites may be associated with severe vitamin D deficiency. Hip fractures still are the most devastating event after osteoporosis due to their impact on length of hospital stay, loss of independence and mortality. Greco and Perisano said sufficient vitamin D levels would allow for better management of musculoskeletal function and should be an essential part of osteoporosis therapy **[13].** The combined effect of poor sunlight exposure was the most influential single factor on vitamin D deficiency (AOR = 4.87, p < 0.001). Around 75% of vitamin D deficient cases indicated that they had poor sun exposure. Even in the highly sun-exposed areas, middle-aged and older people may limit their outdoor activity due to fragility, debilitating health conditions, or inability to move to get to the outdoors, leading to sub-optimal production of vitamin D. The results confirm the existing indications which call for "optimal" sun exposure and

nutritional optimization and supplementation **[20].** Low BMI was also an independent risk factor for vitamin D deficiency, with vitamin D deficiency seen to increase the risk of low BMI (AOR 2.31, p 0.041), indicating that low nutritional status also leads to poor bone health. There were 68% female, but sex of female was not an independent risk marker of vitamin D deficiency after adjustment for the confounding factors. This suggests that the prevalence of vitamin D insufficiency is still very common in both men and women with osteoporosis, consistent with the current global policy of screening high-risk adults, irrespective of gender **[21].** More recently, Arcidiacono *et al.*, in a prospective cohort of 934 patients with hip fractures, reported vitamin D deficiency in 53.6% of patients. Vitamin D deficiency was associated with higher mortality in unadjusted analysis, although this association was attenuated after adjustment for age, sex and comorbidity burden, highlighting the importance of considering vitamin D deficiency within the broader clinical and comorbidity profile of patients with fragility fractures **[22]**. In general, the results of this study justify the general screening of serum 25-hydroxyvitamin D for osteoporosis in patients who receive a diagnosis of frailty fracture. Repairing VDD early and judiciously and ensuring adequate calcium help improve fracture repair, decrease fractures and provide better long-term results coupled with anti-osteoporotic medications, fall prevention and rehabilitation. Such observations are in line with the current International recommendations supporting a multimodal strategy for osteoporosis and fragility fracture prevention and management **[23].**

Conclusion:

Deficiency of vitamin D was also very common in individuals with osteoporotic fractures; in fact, almost three-quarters of the subjects in the study were vitamin D deficient. Old age, low dietary calcium intake, low BMI, low vitamin D exposure from sun and prior fragility fracture were shown to be significant predictors of the presence of vitamin D deficiency. Optimal maintenance of vitamin D status and the initial supplement dose schedule, as well as a standing-order for full osteoporosis management, could be used to help cut down on repeat fracture and optimize patient outcomes.

References:

[1] https://www.niams.nih.gov/health-topics/osteoporosis
[2] Das S *et al. Cureus.* 2025 **17**:e93229. [PMID: 41146827]
[3] Holick MF & Chen TC. *Am J Clin Nutr.* 2008 **87**:1080S. [PMID: 18400738]
[4] https://www.ncbi.nlm.nih.gov/books/NBK532266
[5] Mudiyanselage DE *et al. J Orthop Translat.* 2026 **57**:101061. [PMID: 41777703]
[6] Bouillon R *et al. Endocr Rev.* 2019 **40**:1109. [PMID: 30321335]
[7] Giustina A *et al. Rev Endocr Metab Disord.* 2020 **21**:89. [PMID: 32180081]
[8] Shan PF *et al. Int J Endocrinol.* 2013 **2013**:952858. [PMID: 24223038]
[9] Amrein K *et al. Eur J Clin Nutr.* 2020 **74**:1498. [PMID: 31959942]
[10] Eastell R *et al. J Clin Endocrinol Metab.* 2019 **104**:1595. [PMID: 30907953]
[11] Jha G *et al. Cureus.* 2025 **17**:e97842. [PMID: 41312064]
[12] Gregson CL *et al. Arch Osteoporos.* 2025 **20**:119. [PMID: 40921943]
[13] Greco T & Perisano C. *Medicina (Kaunas).* 2025 **61**:275. [PMID: 40005392]
[14] Qaseem A *et al. Ann Intern Med.* 2024 **177**. [PMID: 38710077]
[15] Agarwal B *et al. Indian J Pharm Sci Res.* 2026 **17**:403. [DOI: 10.13040/IJPSR.0975-8232.17(1).403-07]
[16] Tai TW *et al. J Formos Med Assoc.* 2023 **122**:S4 [PMID: 36781371]
[17] Ek S *et al. Arch Osteoporos.* 2023 **18**:107. [PMID: 37516714]
[18] Dakkak M *et al. Am Fam Physician.* 2023 **108**:100. [PMID: 37440727]
[19] Raj R *et al. SSR Inst Int J Life Sci.* 2026 **12**:9609. [DOI: 10.21276/SSR-IIJLS.2026.12.2.43]
[20] https://aoj.amegroups.org/article/view/9070
[21] Kanis JA *et al. Osteoporos Int.* 2019 **30**:3. [PMID: 30324412]
[22] Arcidiacono GP *et al. J Endocrinol Invest.* 2026 **49**:2913. [DOI: 10.1007/s40618-026-02952-x]
[23] Anish RJ & Nair A. *J Orthop.* 2024 **53**:101. [PMID: 38495575]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.