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An Association Between Vitamin D Status, Complications And Quality Of Life In Osteoarthritis Patients- A Cross-Sectional Study.

Kumar Masum, Dr. Shibi Mary Thomas, Dr. Balakeshwa Ramaiah
Pharm.D, Assistant Professor, Head Of Department Of Pharmacy Practice
Department Of Pharmacy Practice, Karnataka College Of Pharmacy,
Rajiv Gandhi University Of Health Sciences, Bengaluru, Karnataka, India – 560064

Abstract
Introduction: *Osteoarthritis (OA) is a prevalent degenerative joint disorder that causes chronic pain, functional limitation, and disability, particularly among older adults. Emerging evidence suggests that vitamin D deficiency may contribute to increased disease severity and poorer clinical outcomes. This study aimed to determine the prevalence of vitamin D deficiency and its associated complications, and to evaluate its relationship with health-related quality of life in patients with osteoarthritis.*
Materials and Methods: *A six-month cross-sectional study was conducted among 100 patients with clinically and radiographically confirmed osteoarthritis at a tertiary care hospital. Radiographic severity was assessed using the Kellgren–Lawrence grading system. Pain intensity was measured using the Visual Analog Scale (VAS), functional status using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and quality of life using the WHOQOL-BREF questionnaire. Serum vitamin D levels were measured, associated complications were documented, and statistical analyses were performed using appropriate tests.*
Results: *Among the participants, 55% were female, and most were aged 51–70 years. The knee was the most commonly affected joint (68%). Although half had symptoms for less than one year, 50% already demonstrated moderate-to-severe radiographic changes. Vitamin D deficiency (<20 ng/mL) was observed in 68% of patients, while only 9% had sufficient levels. Mean vitamin D levels declined significantly with increasing OA severity, pain intensity, and functional limitation ($p < 0.001$). Deficient patients also reported poorer quality of life and higher rates of falls (88%) and muscle weakness (79%).*
Conclusion: *Vitamin D deficiency is highly prevalent in osteoarthritis patients and is significantly associated with worse clinical outcomes. Routine screening and correction may improve symptom control, functional status, and overall quality of life.*
Keywords: *Osteoarthritis, Vitamin D deficiency, Kellgren–Lawrence grade, Quality of life, Musculoskeletal complications*

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I. Introduction

Osteoarthritis (OA) is the most prevalent chronic joint disorder, characterized by progressive degeneration of articular cartilage, subchondral bone remodeling, and synovial inflammation, leading to pain, stiffness, and reduced joint mobility.[1] It primarily affects weight-bearing joints such as the knees, hips, and spine, although smaller joints of the hands may also be involved.[2] As the disease progresses, cartilage loss may result in "bone-on-bone" articulation, osteophyte formation, and joint deformities, significantly impairing physical function and quality of life.[3] OA is traditionally considered an age-related disorder; however, its etiology is multifactorial, involving mechanical stress, obesity, genetic predisposition, joint injury, and metabolic factors.[4] The global burden of OA is substantial, affecting more than 10% of men and 18% of women aged ≥60 years, with a higher prevalence among postmenopausal women and overweight individuals.[5] The condition contributes significantly to disability, reduced mobility, and increased healthcare utilization worldwide.[6] The pathogenesis of OA involves a complex interplay of cartilage degradation, subchondral bone changes, low-grade inflammation, and osteophyte formation.[7] These structural and biochemical alterations lead to progressive joint space narrowing, chronic pain, stiffness, and functional limitation.[8] Consequently, patients often experience complications such as reduced mobility, muscle weakness, falls, and decreased independence, all of which negatively impact overall quality of life.[9]

Vitamin D, a fat-soluble vitamin essential for calcium homeostasis, bone health, muscle function, and immune regulation, has recently gained attention in the context of osteoarthritis.[10] Vitamin D deficiency is highly prevalent among OA patients and has been associated with increased pain severity, higher radiographic grades,

impaired physical function, and poorer quality of life.[11] Low serum vitamin D levels may contribute to cartilage degeneration, muscle weakness, and increased risk of falls and fractures, thereby exacerbating disease progression.[12] Several factors contribute to vitamin D deficiency in OA patients, including aging, reduced sunlight exposure, inadequate dietary intake, obesity, and comorbid conditions.[13] Emerging evidence suggests that vitamin D deficiency not only influences structural disease progression but also worsens clinical outcomes and functional status.[14] Although supplementation may improve muscle strength and reduce symptoms in some patients, findings remain inconsistent, highlighting the need for further investigation.[15]

Given the significant burden of osteoarthritis and the potential role of vitamin D in disease progression and patient outcomes, this study aims to evaluate the association between vitamin D status, complications, and quality of life in patients with osteoarthritis.

Objectives

Primary objective:

The primary objective of this study was to assess the prevalence of vitamin D deficiency and its associated complications, and to evaluate its relationship with quality of life among patients with osteoarthritis.

Secondary objectives:

The secondary objectives were to assess the severity of osteoarthritis using the Kellgren–Lawrence (KL) grading system, and to determine the prevalence of vitamin D deficiency among osteoarthritis patients. The study also aimed to evaluate complications associated with vitamin D deficiency, including falls, fractures, and muscle weakness. In addition, pain severity was assessed using the Visual Analogue Scale (VAS), physical function was evaluated using the WOMAC physical function subscale, and quality of life was measured using the WHOQOL-BREF (26-item) scale. Furthermore, the study sought to correlate serum vitamin D levels with osteoarthritis severity, pain, physical function, and quality of life, and to identify predictors of vitamin D deficiency, including demographic, lifestyle, and clinical factors.

II. Materials And Methods

Study design and setting

This was a hospital-based cross-sectional observational study conducted at Banglore Baptist hospital, a tertiary care teaching hospital in Bangalore over a period of six months (January to June 2024).

Study population

The study population comprised a total of 100 adult patients aged ≥25 years with clinically and radiologically confirmed osteoarthritis (knee, hip, or hand) attending the outpatient and inpatient departments.

Inclusion criteria

Patients aged ≥25 years with clinically confirmed osteoarthritis who were willing to provide written informed consent and had not received vitamin D supplementation in the preceding three months were included in the study.

Exclusion criteria

Patients were excluded if they had secondary osteoarthritis due to trauma, rheumatoid arthritis, or other inflammatory joint disorders, or a history of high-dose vitamin D therapy or use of medications affecting bone metabolism (such as corticosteroids or bisphosphonates) within the past three months.

Sample size

The sample size was calculated using the standard formula for estimating a proportion in a descriptive study:

Assuming a prevalence (p) of vitamin D deficiency of 50%, with a 95% confidence level (Z = 1.96) and a margin of error (d) of 10%, the calculated sample size was 96, which was rounded off to 100 participants.

Data sources and data collection

Data were collected using a structured case record form (CRF), which included demographic details, clinical history, lifestyle factors, comorbidities, laboratory parameters, and complications. Serum vitamin D levels were obtained from laboratory investigations.Osteoarthritis severity was assessed radiologically using the Kellgren–Lawrence (KL) grading system. Pain intensity was measured using the Visual Analogue Scale (VAS), categorized as mild (1–3), moderate (4–6), and severe (7–10). Physical function was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function subscale, with higher scores indicating greater disability.Quality of life was assessed using the WHOQOL-BREF (26-item) questionnaire, covering physical, psychological, social, and environmental domains, with scores transformed to a 0–100 scale (higher scores indicating better quality of life).

Complications associated with vitamin D deficiency, including muscle weakness, falls, and fractures, were assessed through patient history, clinical examination, and relevant medical records. Muscle strength was evaluated using a handgrip dynamometer, while falls and fractures were recorded based on patient recall and documented evidence.

Study procedure

Eligible patients were recruited after obtaining informed consent. Baseline demographic and clinical data were recorded. Radiological assessment for osteoarthritis grading was performed, followed by evaluation of pain (VAS), physical function (WOMAC), and quality of life (WHOQOL-BREF). Laboratory investigations including serum vitamin D levels were conducted. Data on complications such as falls, fractures, and muscle weakness were collected. All data were compiled for analysis to determine prevalence, associations, and correlations.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical methods. Continuous variables (age, vitamin D levels, VAS, WOMAC, WHOQOL-BREF scores) were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.

Ethical considerations

The study was conducted following ethical principles. Written informed consent was obtained from all participants prior to enrolment. Participants were informed about the voluntary nature of the study and their right to withdraw at any time without affecting their care. Confidentiality and anonymity of patient data were strictly maintained. Data obtained from medical records were used in compliance with institutional ethical standards.

III. Results

A total of 100 patients with osteoarthritis (OA) were included in the study, with females slightly outnumbering males (55% vs. 45%). Most participants were older adults, predominantly aged 51–60 years (27%) and 61–70 years (24%), while 15% were ≥71 years and very few were under 40 years, reflecting the age-related nature of OA; 56% resided in urban areas. The knee was the most commonly affected joint (68%), followed by the hip (17%) and hand (15%). Half of the patients had symptoms for less than one year, whereas 19% had disease duration of ≥5 years. According to the Kellgren–Lawrence grading system, the majority had moderate to severe disease (Grade II: 38%, Grade III: 30%, Grade IV: 20%), with only 12% in Grade I. Vitamin D deficiency was highly prevalent, with 68% having levels <20 ng/mL, 23% showing insufficiency (20–29 ng/mL), and only 9% having sufficient levels (≥30 ng/mL), as presented in Table 1.

Table 1. Demographic Details of Osteoarthritis Patients.

Characteristics	Category	Number of Patients N (%)
Gender	Male	45 (45.0)
	Female	55 (55.0)
Age (years)	26–30	1 (1.0)
	31–40	14 (14.0)
	41–50	19 (19.0)
	51–60	27 (27.0)
	61–70	24 (24.0)
	≥71	15 (15.0)
Residence	Urban	56 (56.0)
	Rural	44 (44.0)
Site of Osteoarthritis	Knee	68 (68.0)
	Hip	17 (17.0)
	Hand	15 (15.0)
Duration of Osteoarthritis	< 6 months	22 (22.0)
	6 months–1 year	28 (28.0)
	1–2 years	23 (23.0)
	2–5 years	8 (8.0)
	≥5 years	19 (19.0)
Kellgren–Lawrence Grade	Grade I	12 (12.0)
	Grade II	38 (38.0)
	Grade III	30 (30.0)
	Grade IV	20 (20.0)
Vitamin D Status (ng/mL)	< 20	68 (68.0)
	20–29	23 (23.0)
	≥ 30	9 (9.0)

Mean serum vitamin D levels showed a significant decline with increasing radiographic severity of osteoarthritis. Patients with KL Grade I disease had the highest mean vitamin D level (30.94 ± 2.09 ng/mL), which progressively decreased in Grade II, Grade III, and Grade IV. This trend was statistically significant ($p < 0.001$), indicating a strong inverse association between vitamin D levels and OA severity, as shown in Table 2.

Table 2. Association of Vitamin D Levels with OA Severity and Pain.

Parameter	Category	Mean Vitamin D (ng/mL) ± SD	p-value
KL Grade	I	30.94 ± 2.09	<0.001
	II	23.11 ± 3.47	
	III	15.16 ± 3.01	
	IV	10.17 ± 4.43	
Pain Severity (VAS)	Mild	31.40 ± 1.87	<0.001
	Moderate	24.23 ± 3.95	
	Severe	12.08 ± 3.48	

KL Grade: Kellgren-Lawrence (KL) grading system, VAS: Visual Analogue Score

A similar trend was observed with pain severity assessed by the VAS, where patients with mild pain had higher mean vitamin D levels (31.40 ± 1.87 ng/mL), which progressively declined in those with moderate and severe pain. This association between lower vitamin D levels and greater pain severity was statistically significant ($p < 0.001$), as shown in Table 2. Likewise, mean vitamin D levels decreased consistently with worsening WOMAC functional status, from 31.8 ng/mL in patients with minimal difficulty to 25.1 ng/mL in mild difficulty, 13.6 ng/mL in moderate limitation, and 8.9 ng/mL in severe functional impairment. This progressive decline with increasing disability was also statistically significant ($p < 0.001$), as demonstrated in Table 3.

Table 3. WOMAC Physical Function Scores and Vitamin D Levels

WOMAC Category	Functional Status	Mean Vitamin D (ng/mL) ± SD	p-value
Minimal	Minimal difficulty	31.77 ± 1.69	<0.001
Mild	Mild difficulty	25.06 ± 3.45	
Moderate	Moderate difficulty	13.60 ± 3.20	
Severe	Severe difficulty	8.91 ± 1.45	

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index

Quality of Life (WHOQOL-BREF) scores improved progressively with higher vitamin D status across all domains. Patients with vitamin D deficiency had the lowest overall quality of life score (45.3), compared to 61.6 in the insufficient group and 74.2 in those with sufficient levels. A similar trend was observed across individual domains, particularly physical health (41.2 vs. 59.3 vs. 72.7). These differences were statistically significant across all domains ($p < 0.001$), indicating a strong positive association between better vitamin D status and improved quality of life, as depicted in Table 4 and Fig. 1.

Table 4. Quality of Life (WHOQOL-BREF) Scores by Vitamin D Status

Vitamin D Status	WHOQOL-BREF Scores					p-value
	Physical	Psychological	Social	Environmental	Overall	
Deficient	41.2	45.7	46.8	47.5	45.3	<0.001
Insufficient	59.3	61.2	62.8	62.9	61.6	<0.001
Sufficient	72.7	74.0	76.3	73.6	74.2	<0.001

WHOQOL-BREF: World Health Organization Quality of Life

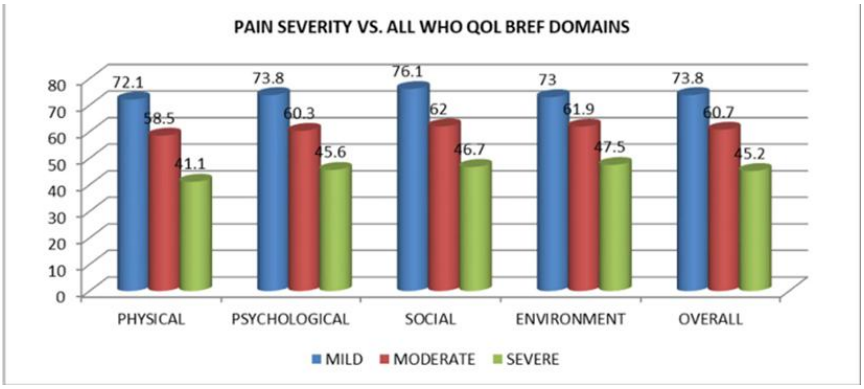

Fig. 1. Quality of Life (WHOQOL-BREF) Scores by Vitamin D Status

Clinical complications were significantly more common among patients with vitamin D deficiency. Muscle weakness was observed in 79.4% of deficient patients compared with 34.8% of insufficient and 66.7% of sufficient individuals. Falls showed the strongest association, occurring in 88.2% of deficient patients versus 43.5% and 22.2% in the insufficient and sufficient groups, respectively. Fractures were reported in 45.6% of deficient patients, while reduced mobility (83.8%) and increased stiffness (80.9%) were also predominantly noted in this group. All complications demonstrated statistically significant associations with vitamin D status ($p < 0.001$), indicating a higher burden of musculoskeletal and functional impairment among vitamin D–deficient individuals, as depicted in Table 5 and Fig. 2.

Table 5. Association of Vitamin D Status with Complications.

Complication	Deficient (N=68)	Insufficient (N=23)	Sufficient (N=9)	p-value
Muscle weakness	54 (79.4%)	8 (34.8%)	6 (66.7%)	<0.001
Falls	60 (88.2%)	10 (43.5%)	2 (22.2%)	<0.001
Fractures	31 (45.6%)	5 (21.7%)	6 (66.7%)	<0.001
Reduced mobility	57 (83.8%)	6 (26.1%)	6 (66.7%)	<0.001
Increased stiffness	55 (80.9%)	9 (39.1%)	6 (66.7%)	<0.001

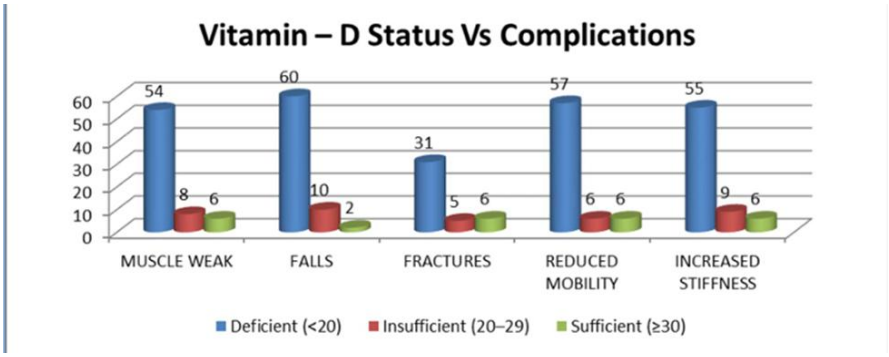

Fig. 2. Association of Vitamin D Status with Complications.

IV. Discussion

In the present study, a higher proportion of females (55%) compared to males (45%) was observed, with the majority of patients belonging to the 51–60 years age group. These findings are consistent with existing epidemiological evidence indicating that osteoarthritis (OA) is more prevalent in older individuals and females, possibly due to hormonal influences, postmenopausal changes, and differences in joint biomechanics. Similar age and gender distributions have been reported in previous studies, including Indian cohorts of knee OA patients, supporting the external validity of our findings.[16]

The majority of patients in our study had advanced radiographic OA (Kellgren–Lawrence grade III–IV), with the knee being the most commonly affected joint (68%). This aligns with global data demonstrating that weight-bearing joints, particularly the knee, are more susceptible to OA due to mechanical stress and aging. Furthermore, previous studies have shown that lower vitamin D levels are associated with higher radiographic severity, which is in agreement with our observations.[17]

A high prevalence of vitamin D deficiency (68%) was noted in our cohort, with only 9% of patients having sufficient levels. These findings are comparable to those of a meta-analysis reporting a pooled prevalence of approximately 56.7% among OA patients, as well as retrospective studies indicating prevalence rates exceeding 70%. This consistency suggests that vitamin D deficiency is highly prevalent among OA patients and may represent a significant comorbidity rather than an incidental finding.[18]

A strong negative correlation ($r \approx -0.88$) was observed between serum vitamin D levels and OA severity (KL grade), indicating that lower vitamin D levels are associated with more advanced disease. This finding is consistent with previous cross-sectional studies demonstrating significantly lower vitamin D levels in patients with severe radiographic OA (grades III–IV). Such observations support the hypothesis that vitamin D may play a role in cartilage metabolism and joint remodeling.[19]

Pain severity assessed by the Visual Analogue Scale (VAS) showed a strong inverse correlation with vitamin D levels ($r \approx -0.92$), with patients experiencing severe pain having markedly lower vitamin D levels. While some studies, such as those by Heidari et al., have not demonstrated a significant association between vitamin D and pain severity, other studies have reported similar inverse relationships. Therefore, our findings are partially consistent with existing literature, suggesting that vitamin D deficiency may contribute to increased pain perception in OA.[20, 21]

A very strong positive correlation ($r \approx 0.95$) was observed between vitamin D levels and WOMAC physical function scores, indicating better functional status with higher vitamin D levels. This is in agreement with previous studies that have demonstrated an association between low vitamin D levels and poorer functional outcomes, possibly mediated through inflammatory pathways involving cytokines such as IL-6 and TNF-α. These findings reinforce the potential role of vitamin D in maintaining musculoskeletal function.[22]

Quality of life (QOL), assessed using the WHOQOL-BREF scale, was significantly better in patients with higher vitamin D levels across all domains, particularly physical health. Although limited OA-specific studies have evaluated QOL using WHOQOL-BREF, available evidence suggests that vitamin D supplementation may improve physical performance and overall well-being. Thus, our findings are consistent with the broader literature linking vitamin D status to improved quality of life in chronic musculoskeletal conditions.[23]

The study also demonstrated a high prevalence of complications, including muscle weakness (68%), reduced mobility (69%), stiffness (70%), falls (72%), and fractures (42%), all of which were significantly associated with vitamin D deficiency ($p < 0.001$). These findings are biologically plausible, as vitamin D plays a crucial role in calcium homeostasis, muscle strength, and neuromuscular coordination. Previous studies have similarly reported increased risks of falls, fractures, and frailty among individuals with vitamin D deficiency, supporting our observations.[24]

Furthermore, factors such as older age, higher KL grade, severe pain, poor functional status, and lower quality of life were identified as strong predictors of vitamin D deficiency in our study. These findings are consistent with previous meta-analyses and observational studies that have identified age, disease severity, and systemic inflammation as important determinants of vitamin D status in OA patients.[25]

V. Conclusion

In conclusion, this study demonstrates a high prevalence of vitamin D deficiency among osteoarthritis patients, with 68% deficient and only a small proportion having adequate levels, underscoring its clinical significance. Lower vitamin D levels were strongly associated with advanced disease severity (KL grade III–IV), increased pain, poorer physical function, higher complication rates (including muscle weakness, falls, and fractures), and reduced quality of life across all domains, highlighting its potential role in disease progression and patient outcomes. These findings are consistent with existing literature and reinforce the importance of vitamin D as a modifiable risk factor in osteoarthritis. Routine screening and timely correction of vitamin D deficiency may offer a simple and cost-effective strategy to improve pain, functional status, and overall well-being in these patients. Furthermore, this study adds to the growing body of evidence emphasizing the need to integrate vitamin D assessment into standard osteoarthritis management, particularly in older adults and those with advanced disease. Future research should focus on large-scale longitudinal and interventional studies to establish causal relationships and evaluate the therapeutic impact of vitamin D supplementation on disease progression, functional outcomes, and quality of life, thereby strengthening its role in evidence-based clinical practice.

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Abbreviations:

OA: Osteoarthritis ; KLgrade: Kellgren–Lawrence grade; VAS: Visual Analogue Scale; WHOQOL-BREF: World health organisation Quality of Life

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