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A prospective evaluation of vitamin D levels and knee osteoarthritis risk: A cohort study

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Abstract
Background: Osteoarthritis (OA) is a chronic degenerative disorder, and vitamin D deficiency is a potential modifiable risk factor. This study aimed to assess the association between serum vitamin D levels and knee OA in adults and evaluate the effect of vitamin D therapy on OA progression.
Methods: This prospective cohort study included 100 patients with knee OA, aged 40-100 years, who met specific inclusion criteria. Patients were diagnosed with primary OA, and serum vitamin D levels were classified as deficient (< 20 ng/ml), insufficient (20-30 ng/ml), or normal (≥ 30 ng/ml). The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score was used to assess symptom severity. Patients were followed up at 6 and 12 months to assess changes in X-rays, vitamin D levels, and WOMAC scores.
Results: At baseline, 54% of patients were vitamin D deficient, 40% were insufficient, and 6% had normal levels. By the second follow-up, 98% had normal levels. The mean vitamin D level increased significantly over time (p<0.01). The mean WOMAC score decreased significantly over time (p<0.01), indicating symptom improvement. Significant differences were found in mean ages and vitamin D levels according to Kellgren-Lawrence grading in unilateral and bilateral cases.
Conclusion: This study found a significant association between serum vitamin D levels and knee OA risk. Vitamin D therapy improved vitamin D levels and reduced symptom severity over time. These findings suggest that vitamin D supplementation may be beneficial in preventing or slowing knee OA progression. Further studies are needed to confirm these results and establish vitamin D supplementation as a standard treatment for knee OA.

Keywords: Degenerative disorder, kellgren-lawrence grading, knee osteoarthritis, Vitamin D, womac score

Introduction

Osteoarthritis (OA) is a chronic degenerative disorder characterized by loss of articular cartilage, hypertrophy of bone at the margins, subchondral sclerosis and range of biochemical and morphological alterations of the synovial membrane and joint capsule. Pathological changes in the late stage of OA include softening, ulceration and focal disintegration of the articular cartilage; synovial inflammation may also occur. Typical clinical symptoms are pain, particularly after prolonged activity and weight bearing; whereas stiffness is experienced after inactivity [1].

When considering non-modifiable factors for Osteoarthritis (OA), age and sex are the strongest predictors. OA is not a simple consequence of joint aging and repeated "wear and tear", but a consequence of cumulative exposure to various risk factors and biologic changes that occur with aging, such as chondrocyte senescence, loss of cartilage matrix and oxidative damage [2]. In contrast, obesity and vitamin D deficiency are modifiable risk factors [3]. Increasing epidemiological evidence has suggested that insufficient serum vitamin D status is associated with the progression of OA and worsening in its symptoms [4].

It is well known that vitamin D has an important influence on the state of many articular structures, such as cartilage and subchondral bone, as well as muscle tissues, all of which play a part in the progression of knee [5]. Vitamin D deficiency is a under diagnosed medical condition since a significant proportion of the population in many countries and regions around the world have low serum 25-OH vitamin D levels [6].

The findings from high-quality prospective studies about the association between vitamin D deficiency and OA were inconsistent, strong evidence had suggested vitamin D deficiency is linked with the risks of cartilage loss, when joint space loss and change in cartilage volume measurement were combined, in knee OA [7-10]. Furthermore, nonexperimental studies suggested that vitamin D supplementation in people with knee OA decreased pain, improved physical function and quality of life [11]. as well as slowed down the progression of knee joint abnormalities [12-13]. However, most randomized controlled trials (RCTs) to date showed that vitamin D supplementation did not improve knee pain or cartilage volume. As a result, the role of vitamin D supplementation in the treatment or prevention of knee OA remains uncertain. A few recent literature reviews on the topic of vitamin D and knee OA have called for more well-designed studies to reconcile these conflicting findings [14]. Therefore, the aim of the study is to assess the association of serum vitamin D levels and knee Osteoarthritis in the adult population and to study the effect of vitamin D therapy on progression of knee Osteoarthritis.

Materials and Method

The present prospective cohort study was conducted among 100 patients with knee osteoarthritis (OA) at the Department of Orthopaedics in People's College of Medical Sciences and Research Centre associated with People's Hospital in Bhopal. The study received ethical clearance from the institution's ethical committee and was carried out over a period of 18 months. The study recruited patients with knee osteoarthritis (OA) who met the inclusion criteria and visited the Orthopaedics department's outpatient clinic during the study period. The study included patients diagnosed with primary osteoarthritis of the knee, either unilateral or bilateral, aged between 40 and 100 years. However, patients with certain conditions were excluded, such as those with physical disabilities due to trauma, infections, tumors, or previous knee surgery, as well as those taking anticonvulsant drugs. Additionally, patients with chronic kidney disease, gastrointestinal disorders, or a variation of 2 or more in the Kellgren-Lawrence classification between knees were also excluded from the study. These criteria ensured a specific and homogeneous study population to investigate the association between serum vitamin D levels and knee osteoarthritis.

Patients presenting with knee complaints were diagnosed with osteoarthritis based on clinical symptoms and radiological findings. X-rays were taken to confirm diagnosis and classify severity using the Kellgren-Lawrence grading system (Grade 0-4). Demographic information, medical history, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score was used to assess the severity of symptoms in patients with osteoarthritis knee. The WOMAC score is a standardized questionnaire that evaluates pain, stiffness, and physical functioning of the knee joints. It consists of 24 items, divided into three subscales: pain (5 items), stiffness (2 items), and physical function (17 items). Each item is scored on a scale of 0-4, the total WOMAC score ranges from 0-59, with higher scores indicating worse pain, stiffness, and functional limitations.

Blood samples were collected to measure serum vitamin D3 levels, which were classified as deficient (< 20 ng/ml), insufficient (20-30 ng/ml), or normal (≥ 30 ng/ml). Patients were followed up at 6 and 12 months to assess changes in x-rays, vitamin D levels, and WOMAC scores.

Inclusion criteria

- Patients diagnosed as Primary Osteoarthritis Knee in Unilateral and Bilateral
- Age group between – >40 years.

Exclusion criteria

- Patients with physical disabilities (Trauma, infections, tumours or any previous surgery of knee joint).
- Patients on anticonvulsant drugs, Material and Methods Page 7.
- Patients having chronic kidney diseases or gastrointestinal disorders.
- Patients with variation in Kellgren Lawrence classification of 2 or more between the knees.

Statistical analysis

The collected data was analyzed by using IBM-SPSS version 22.0. Analysis was done in the form of percentages, proportions and represented as tables, charts, and graphs wherever necessary. Appropriate tests of significance were applied.

Results

Table 1 shows age group distribution according to vitamin D categories. This table presents the age group distribution of study subjects according to their Vitamin D categories. For subjects with Vitamin D levels <20 ng/ml, 14 were aged 41-50 (25.9%), 20 were aged 51-60 (37.0%), and 20 were aged >60 (37.0%). For those with Vitamin D levels between 20-30 ng/ml, 10 were aged 41-50 (25.0%), 15 were aged 51-60 (37.5%), and 15 were aged >60 (37.5%). In the >30 ng/ml category, 2 were aged 41-50 (33.3%), 3 were aged 51-60 (50.0%), and only 1 was aged >60 (16.7%).

Table 2 shows the distribution of subjects' sunlight exposure according to their Vitamin D categories. In the <20 ng/ml category, 38 subjects (70.4%) had less than 1 hour of sunlight exposure per day, 16 subjects (29.6%) had 1-2 hours of exposure, and none had more than 2 hours. For the 20-30 ng/ml category, 10 subjects (25.0%) had less than 1 hour of exposure, 22 subjects (55.0%) had 1-2 hours, and 8 subjects (20.0%) had more than 2 hours. In the >30 ng/ml category, 1 subject (16.7%) had less than 1 hour of exposure, 1 subject (16.7%) had 1-2 hours, and 4 subjects (66.7%) had more than 2 hours.

Table 3 shows Vitamin D grading across different time intervals. At baseline, 54 subjects (54.0%) were deficient, 40 (40.0%) were insufficient, and 6 (6.0%) had normal levels. At the first follow-up, 6 (6.0%) were deficient, 15 (15.0%) were insufficient, and 79 (79.0%) had normal levels. By the second follow-up, no subjects were deficient, 2 (2.0%) were insufficient, and 98 (98.0%) had normal levels. The p-value indicates significant improvement over time (p<0.01).

Table 4 shows the mean Vitamin D and WOMAC scores at baseline, first follow-up, and second follow-up. The mean Vitamin D3 level increased from 19.35±7.80 ng/ml at baseline to 31.53±6.46 ng/ml at first follow-up and 38.81±4.91 ng/ml at the second follow-up (p<0.01). The mean WOMAC score decreased from 42.61±11.11 at baseline to 36.00±10.71 at first follow-up and 34.05±10.77

at the second follow-up ($p<0.01$), indicating improvement in symptoms.

Table 5 compares the mean age of subjects according to the Kellgren-Lawrence (KL) grading of the left and right knees in unilateral and bilateral cases. For unilateral cases, the mean age for stage I in the right knee was 51.29±6.13, stage II was 53.86±9.35, while bilateral right stage II cases had a mean age of 58.78±11.15. Bilateral stage III cases had a mean age of 64.06±10.61 for the right knee and 64.37±11.39 for the left knee. The p-values show significant differences in mean ages for bilateral cases ($p<0.01$ for the right knee and P=0.048 for the left knee).

Table 6 presents the mean Vitamin D3 levels according to the Kellgren-Lawrence (KL) grading of unilateral and bilateral cases at different time intervals. At baseline, for unilateral cases, stage I right knee had a mean Vitamin D3 level of 14.20±5.29 ng/ml. For bilateral cases, stage II right knee had a mean Vitamin D3 level of 19.94±7.21 ng/ml. At the first follow-up, stage II right knee in bilateral cases had a mean Vitamin D3 level of 31.53±6.22 ng/ml. At the second follow-up, stage II right knee in bilateral cases had a mean Vitamin D3 level of 39.00±4.77 ng/ml. The p-values show significant differences in mean Vitamin D3 levels at baseline for unilateral right knee cases (P=0.046).

Table 7 compares the mean WOMAC scores according to the Kellgren-Lawrence (KL) grading of unilateral and bilateral cases at different time intervals. At baseline, for unilateral cases, stage I right knee had a mean WOMAC score of 45.57±7.93. For bilateral cases, stage II right knee had a mean WOMAC score of 40.03±8.93. At the first follow-up, stage II right knee in bilateral cases had a mean WOMAC score of 32.94±7.76. At the second follow-up, stage II right knee in bilateral cases had a mean WOMAC score of 33.51±7.71. The p-values show significant differences in mean WOMAC scores at the first follow-up for bilateral right knee cases (P=0.010).

Table 1: Age group wise distribution of study subjects according to Vit D categories

Years	<20 ng/ml		20-30 ng/ml		>30 ng/ml	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
41-50	14	25.9	10	25.0	2	33.3
51-60	20	37.0	15	37.5	3	50.0
>60	20	37.0	15	37.5	1	16.7
Total	54	100.0	40	100.0	6	100.0

Table 2: Sunlight exposure wise distribution of study subjects

	<20 ng/ml		20-30 ng/ml		>30 ng/ml		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
<1 hr/day	38	70.4	10	25	1	16.7	49	49.0
>2 hr/day	0	0	8	20	4	66.7	12	12.0
1-2 hr/day	16	29.6	22	55	1	16.7	39	39.0

Table 3: Vit D3 grading at different time intervals

	Deficiency (<20 ng/ml)		Insufficient (20-30 ng/ml)		Normal (>30 ng/ml)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Baseline	54	54.0	40	40.0	6	6.0
1st follow up	6	6.0	15	15.0	79	79.0
2nd follow up	0	0.0	2	2.0	98	98.0

P-Value -<0.01*

Table 4: Mean Vitamin D and WOMAC scores at different time intervals

	Baseline		1st follow up		2nd follow-up		P-Value
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	
Vitamin D3	19.35	7.80	31.53	6.46	38.81	4.91	<0.01*
WOMAC	42.61	11.11	36.00	10.71	34.05	10.77	<0.01*

Table 5: Comparison of mean age according KL grading of left and right knee

	Unilateral				Bilateral			
	Right		Left		Right		Left	
	Mean (Age in Years)	Std. Deviation	Mean (Age in Years)	Std. Deviation	Mean (Age in Years)	Std. Deviation	Mean (Age in Years)	Std. Deviation
Normal	52.57	7.71	53.00	3.35	--	--	--	--
I	51.29	6.13	53.00	4.05	50.75	4.03	51.00	2.83
II	53.86	9.35	52.57	7.71	58.78	11.15	58.56	10.83
III	--	--	--	--	64.06	10.61	64.37	11.39
IV	--	--	--	--	--	--	69.50	10.63
P-Value	0.830		.986		<0.01*		.048*	

Table 6a: Comparison of mean Vit D3 level according KL grading of unilateral cases at different time interval

	Unilateral			
	Right Knee		Left Knee	
	Mean	Std. Deviation	Mean	Std. Deviation
Normal	19.06	8.81	19.36	5.46
I	14.2	5.29	21.37	5.05
II	23.93	9.22	15.33	4.35
III	--	--	--	--
IV	--	--	--	--
P-Value	.046*		0.546	
1st follow-up				
Normal	29.88	6.11	30.04	4.5
I	31.69	3.62	31.57	5.03
II	32.07	7.52	29	3.9
III	--	--	--	--
IV	--	--	--	--
P-Value	0.333		0.925	
2nd follow-up				
Normal	39.21	4.1	38.64	4.76
I	38.77	2.77	39.4	4.09
II	39.66	5.32	37.13	6.6
III	--	--	--	--
IV	--	--	--	--
P-Value	0.893		0.738	

Table 6b: Comparison of mean Vit D3 level according KL grading of bilateral cases at different time interval

	Left Knee							
	I		II		III		IV	
Right Knee	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Baseline								
I	0	0	22.04	13.33	0	0	0	0
II	22.90	0	20.47	8.11	17.20	3.72	20.90	3.25
III	8.10	0	19.31	7.43	16.75	7.06	20.35	1.20
IV	0	0	0	0	18.00	0	0	0
P-Value	NA		0.04*		0.05		0.845	
1st follow up								
I	0	0	31.35	11.61	0	0	0	0
II	36.80	0	29.87	6.79	26.73	3.47	31.20	2.69
III	21.60	0	29.10	5.57	29.02	7.29	28.40	3.25
IV	0	0	0	0	28.60	0	0	0
P-Value	NA		0.05*		0.0047*		0.03*	
2nd follow up								
I	0	0	39.74	9.61	0	0	0	0
II	41.83	0	38.73	5.32	38.74	2.59	42.10	3.82
III	33.20	0	38.02	3.38	38.87	5.22	39.55	2.90
IV	0	0	0.00	0.00	36.80	0.00	0.00	0.00
P-Value	NA		0.07		0.16		0.041*	

Table 7a: Comparison of mean WOMAC score according KL grading in unilateral cases

	Unilateral			
	Right		Left	
	Mean	Std. Deviation	Mean	Std. Deviation
Baseline				
Normal	30.93	5.14	33.56	4.64
I	30.57	4.76	32.67	4.63
II	32.29	4.64	35.33	5.03
III	--	--	--	--
IV	--	--	--	--
P-Value	0.096		0.372	
1st follow up				
Normal	27.36	3.73	30	4.56
I	24.86	4.06	27.67	4.76
II	27.86	2.91	30.67	5.03
III	--	--	--	--
IV	--	--	--	--
P-Value	0.136		0.332	
2nd follow up				
Normal	23.43	4.47	26.67	4.3
I	21	4.04	25.33	4.59
II	23.86	5.15	27.33	4.51
III	--	--	--	--
IV	--	--	--	--
P-Value	0.251		0.255	

Table 7b: Comparison of mean WOMAC score according KL grading in bilateral cases

	Left							
	I		II		III		IV	
Right	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**
Baseline								
I	0.0	0.0	38.00	5.40	0.0	0.0	0.0	0.0
II	45.00		37.63	5.29	48.86	9.91	68.50	0.71
III	41.00		50.06	6.27	53.64	4.90	65.00	12.73
IV	0	0	0	0	70.00	0	0	0
P-Value	NA		0.05*		0.03*		0.048*	
1st follow up								
I	0.0	0.0	31.63	6.32	0.0	0.0	0.0	0.0
II	41.00		33.52	4.75	42.29	8.56	64.50	0.71
III	36.00		45.29	6.71	48.09	5.58	60.00	14.14
IV	0	0	0	0	68.00	0	0	0
P-Value	NA		<0.01*		<0.01*		0.05*	
2nd follow up								
I	0.0	0.0	26.25	8.96	0.0	0.0	0.0	0.0
II	35.00		30.30	5.47	37.71	9.45	60.50	0.71
III	33.00		41.24	6.42	44.09	4.91	51.50	13.44
IV	0.0	0.0	0.00	0.00	67.00	0.00	0.00	0.00
P-Value	NA		< 0.01*		< 0.01*		< 0.01*	

Discussion

This prospective cohort study aimed to investigate the association between vitamin D deficiency and primary osteoarthritis (OA) of the knee, exploring various clinicalo-radiological factors. The findings provide a comprehensive understanding of how vitamin D status and other factors influence the progression and severity of knee OA. The study revealed significant relationships between age, sunlight exposure, and vitamin D levels, contributing to our understanding of the multifaceted nature of knee OA.

In our study, among subjects aged 41-50 Years, 14 (25.9%) had <20 ng/ml Vitamin D Levels, 10 (25.0%) had 20-30 ng/ml Vitamin D Levels, and 2 (33.3%) had >30 ng/ml of Vitamin D Levels. For ages 51-60, 20 (37.0%) were in the <20 ng/ml category, 15 (37.5%) in the 20-30 ng/ml, and 3 (50.0%) in the >30 ng/ml. In the >60 age group, 20 (37.0%) had <20 ng/ml, 15 (37.5%) had 20-30 ng/ml, and 1 (16.7%) had >30 ng/ml. The age distribution analysis showed that subjects with lower vitamin D levels (<20 ng/ml) were predominantly older, with a notable concentration in the age groups 51-60 and >60. This aligns with previous studies that have reported an increased prevalence of vitamin D deficiency among older adults due to reduced skin synthesis and dietary intake (Holick, 2007) [15]. However, some studies have found no significant age-related differences in vitamin D levels among OA patients, suggesting that other factors, such as lifestyle and comorbid conditions, might also play a crucial role (Macfarlane *et al*., 2016) [16].

In our study, on analysing the relation of sunlight exposure and Vitamin D levels revealed that among those with <20 ng/ml, 38 (70.4%) had <1 hr/day, 16 (29.6%) had 1-2 hrs/day, and none had >2 hrs/day. For 20-30 ng/ml, 10 (25.0%) had <1 hr/day, 22 (55.0%) had 1-2 hrs/day, and 8 (20.0%) had >2 hrs/day. For >30 ng/ml, 1 (16.7%) had <1 hr/day, 1 (16.7%) had 1-2 hrs/day, and 4 (66.7%) had >2 hrs/day.

Subjects with less than one hour of sunlight exposure per day had significantly lower vitamin D levels, supporting the well-documented role of sunlight in vitamin D synthesis (Wacker & Holick, 2013) [17]. Increased sunlight exposure was associated with higher vitamin D levels, reinforcing the need for adequate sun exposure as part of public health recommendations to prevent vitamin D deficiency. Similar findings have been reported in other studies, where limited sunlight exposure was directly linked to lower vitamin D levels and higher OA severity (Bischoff-Ferrari *et al*., 2006) [18]. Nevertheless, some research indicates that dietary sources and supplementation can also play a vital role in maintaining adequate vitamin D levels, especially in regions with limited sunlight (Cashman *et al*., 2016) [2].

In our study, unilateral cases by KL grading. For the right knee, 7 (50.0%) were grade I and 7 (50.0%) were grade II. For the left knee, 6 (66.7%) were grade I and 3 (33.3%) were grade II. No subjects had grades III or IV. For Bilateral cases, the right knee, 1 subject was grade II, 0 were grade I, 8 were grade II, and 1 was grade IV. For the left knee, 8 were grade I, 27 were grade II, 18 were grade III, and none were grade IV. The total shows 1 grade I, 53 grade II, 19 grade III, and 4 grade IV cases.

These findings align with studies that report a higher prevalence of Grade I & II in Unilateral cases and Grade II & III in bilateral cases osteoarthritis Knee in populations. For instance, a study by Cushnaghan *et al*. (1991) [19] reported a similar distribution, with most OA cases falling within the KL grades I and II. Additionally, Hart *et al*. (1994) [20] observed that grades III and IV were less common in community-based populations, supporting our findings of fewer high-grade OA cases.

Conversely, other studies have reported different distributions. For example, Muraki *et al*. (2009) found a higher prevalence of advanced OA (grades III and IV) in older populations, suggesting that age and duration of disease might influence the severity observed. Furthermore, a study conducted in rural India by Sharma *et al*. (2007) [21] reported a significant number of higher-grade OA cases, possibly due to differences in physical activity levels and occupational hazards. Justifications for these variations could include demographic differences, such as age and occupation, and methodological differences, such as the criteria used for grading and population characteristics. The variability in KL grading distributions across studies highlights the importance of considering population-specific factors when interpreting OA severity.

The Kellgren-Lawrence (KL) grading system analysis showed significant correlations between vitamin D levels and the severity of OA. Lower vitamin D levels were associated with higher KL grades, indicating more severe OA. This is consistent with research suggesting that vitamin D deficiency may contribute to the progression of OA by affecting bone and cartilage health (Hunter & Bierma-Zeinstra, 2019) [3]. Moreover, vitamin D has been shown to have anti-inflammatory properties, which might help mitigate OA symptoms and progression (DeLuca, 2004) [4]. However, some studies have not found a significant association between vitamin D levels and OA severity, suggesting that vitamin D might play a role in conjunction with other factors such as genetics and overall health status (Barker *et al*., 2014) [5].

In our study, while assessing vitamin D levels at baseline, 54 (54.0%) were deficient (<20 ng/ml), 40 (40.0%) were insufficient (20-30 ng/ml), and 6 (6.0%) were normal (>30 ng/ml). At the first follow-up, 6 (6.0%) were deficient, 15 (15.0%) were insufficient, and 79 (79.0%) were normal. At the second follow-up, 0 were deficient, 2 (2.0%) were insufficient, and 98 (98.0%) were normal, indicating Statistical significant with p value <0.01.

Vitamin D plays a crucial role in osteoarthritis (OA) through several mechanisms, including maintaining chondrocyte health and cartilage condition, modulating inflammation, and ensuring proper bone remodeling. It stimulates the synthesis of proteoglycans in mature articular cartilage, which are vital for cartilage structure and function (Heidari *et al*., 2011) [22]. Additionally, Vitamin D's anti-inflammatory properties help reduce the production of pro-inflammatory cytokines, potentially slowing OA progression and alleviating symptoms (McAlindon *et al*., 1996) [6]. Adequate Vitamin D levels are essential for calcium absorption and bone mineral density (BMD), crucial for subchondral bone health; deficiency can lead to decreased BMD and subchondral bone changes, contributing to OA progression (Bergink *et al*., 2009) [23]. However, the relationship between Vitamin D levels and OA severity remains controversial, with some studies finding no significant association (Heidari *et al*., 2011; McAlindon *et al*., 1996) [22, 6]. Despite these conflicting findings, routine screening and correction of Vitamin D deficiency in OA patients could potentially slow disease progression and improve outcomes (Bergink *et al*., 2009) [23].

In our study, the mean Vitamin D3 increased from 19.35 ng/ml (baseline) to 31.53 ng/ml (first follow-up) and 38.81 ng/ml (second follow-up), with a p value <0.01. WOMAC scores improved statistically significantly from 42.61 at baseline to 36.00 at the first follow-up and 34.05 at the second follow-up, with a p-value <0.01.

The study's follow-up data demonstrated significant improvements in vitamin D levels and WOMAC scores over time, indicating that correcting vitamin D deficiency may help alleviate OA symptoms and improve patient outcomes. This supports the hypothesis that vitamin D supplementation could be beneficial for OA patients, particularly those with low baseline levels (McAlindon *et al*., 2013) [24]. Nonetheless, randomized controlled trials are necessary to establish the efficacy and safety of vitamin D supplementation in this context, as some studies have reported mixed results regarding its impact on OA progression and symptom relief (Sanghi *et al*., 2013) [25].

Vitamin D levels have been studied in relation to the Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores in osteoarthritis (OA) patients to determine their impact on pain, stiffness, and physical function. While Vitamin D is known to influence cartilage health, inflammation, and bone remodeling, its direct relationship with WOMAC scores remains inconclusive. Some studies suggest that Vitamin D deficiency might exacerbate OA symptoms, leading to higher WOMAC scores due to increased pain and reduced function. Heidari *et al*. (2011) [22]. observed that lower serum Vitamin D levels were associated with more severe OA symptoms, implying higher WOMAC scores. However, other studies have found no significant correlation between Vitamin D levels and WOMAC scores, indicating that factors such as age, BMI, and pain might have a more direct impact on OA severity and patient-reported outcomes (McAlindon *et al*., 1996; Bergink *et al*., 2009) [6, 23]. Despite the mixed findings, addressing Vitamin D deficiency in OA patients could potentially improve their overall condition and quality of life by mitigating some of the disease's symptomatic burdens.

Conclusion

In conclusion, the thesis establishes a significant association between vitamin D deficiency and the severity of primary osteoarthritis in knee patients. Patients with severe vitamin D deficiency were predominantly in the 51-60 and over 60 age groups.

Gender-wise distribution showed a higher prevalence of severe deficiency in females compared to males. Analysis by BMI revealed that both underweight and overweight individuals had a higher prevalence of vitamin D deficiency. Furthermore, patients with less sunlight exposure had more severe vitamin D deficiency. The Kellgren-Lawrence grading demonstrated that patients with lower vitamin D levels had more severe OA (grades III and IV)

The findings emphasize the need for regular assessment and appropriate management of vitamin D levels as part of the treatment plan for OA patients. Addressing vitamin D deficiency can lead to better management of osteoarthritis, reduce symptom severity, and improve the overall quality of life for those affected. Regular monitoring and supplementation of vitamin D are crucial steps in the effective management of knee osteoarthritis

Conflict of Interest

Not available

Financial Support

Not available

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