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Does the level of vitamin D influence pain intensity, functional ability, and quality of life in individuals with chronic low back pain?

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Abstract

Aim: This study aimed to determine the association connection vitamin D level and demographics, duration of pain, pain intensities, neuropathic pain intensities, functional abilities, and quality of life in patients with chronic mechanical low back pain.

Materials and Methods: After blood samples were taken to analyze serum 25 hydroxyvitamin-D, the participants were organized into two groups: those with vitamin D level >20 ng/mL, which was considered sufficient or insufficient, and those with level ≤20 ng/mL, which was considered deficient. The participants' resting, activity, and night pain levels were recorded with the visual analog scale (VAS), neuropathic pain using Douleur Neuropathic 4 (DN4), functional abilities using the Oswestry Disability Index, and quality of life using the 36-item Short-Form Health Survey.

Results: This study included 157 participants. The patients in the vitamin D level >20 ng/mL group were considerably older than those in the vitamin D level ≤20 ng/mL group. Furthermore, the vitamin D level >20 ng/mL group had higher educational level than the other group. While the vitamin D level >20 ng/mL group had lower VAS-resting and VAS-activity scores than the vitamin D level ≤20 ng/mL group, no meaningful disparity was detected between them in terms of night pain VAS score, DN4, pain duration, disability, and quality of life.

Conclusion: The results indicated that differences exist between vitamin D deficiency and chronic low back pain in terms of age, educational level, smoking, and pain level. According to the results, vitamin D level in patients with chronic low back pain was correlated with young age, smoking habit, low educational level, and high pain level.

Introduction

Low back pain is an important and prevalent health concern that leads to serious social and economic consequences [1]. Although there are numerous pathologies in its etiology, the most common is mechanical low back pain, which is caused by overuse, injury, or deformity of the normal anatomical structure. Chronic low back pain is characterized as a backache that lasts for over 12 weeks [2]. The yearly occurrence of low back pain in the general population is estimated to range from 10–30%, while the lifetime prevalence is reported to be between 65–80%. The progression to chronic low back pain can make it hard in performing daily activities. This significantly affects the patient's ability to work [2,3]. Previous history of low back pain, obesity, heavy physical activities, poor general health, smoking habit, and depression are considered as risk factors of low back pain [1,4].

Vitamin D, a nutrient, can also be classified as a hormone. It is essential for regulating calcium levels as well as for the development and preservation of a robust skeletal structure throughout life. Furthermore, vitamin D actively contributes to the correct functioning of muscles and the nervous system, thereby supporting an individuals' overall health [5,6]. The impact of vitamin D on pain is well recognized, and various hypotheses have been suggested to explain the underlying mechanisms [7,8].

Moreover, numerous researchers have revealed a link in comparison to vitamin D deficiency and chronic painful conditions [4]. However, the evidence regarding vitamin D levels in individuals with and without low back pain, and how these levels influence pain intensity in those with low back pain, is inconsistent. Some studies have reported a positive correlation linking vitamin D deficiency and low back pain [4, 9] as well as connecting vitamin D levels and

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pain intensity [10]. Conversely, other studies have found no association [11].

An increasing number of studies are exploring the impacts of vitamin D on pain related to the musculoskeletal system; however, its influence on the demographics, disability, and quality of life of patients with chronic mechanical low back pain remains unclear. Therefore, this study sought to analyze the connection of vitamin D levels with various factors in patients with chronic mechanical low back pain, such as demographics, duration of chronic low back pain, pain intensity, neuropathic pain intensity, functional capabilities, and quality of life.

Materials and Methods

This cross-sectional observational study took place from April 2024 to June 2024, with prior approval from the Ethics Committee at the University of Health Sciences (24/272).

G*Power program was used to calculate the sample size. In the intergroup comparisons of the parameter distributions (VAS Score and ODI Score) that we examined in the reference and preliminary study results (12), it was observed that the effect size was at the level of 0.48. With an effect size of 0.48, the statistical significance coefficient was accepted as 0.05, and it was decided to include at least 54 people in each group in order to obtain 80% power (Total 108).

Patients aged 18–75 years with mechanical low back pain (pain duration ≥ 3 months), with or without leg pain radiation, were eligible to take part in the study. Patients who had a history of surgery in the lumbar spine and/or hip area; a history of neurological or rheumatological diseases; symptomatic hip, knee, or ankle osteoarthritis; metabolic bone disease; chronic kidney disease; and medical or surgical disorders affecting vitamin D metabolism, as well as those who were pregnant or using drugs or supplements that alter bone metabolism, such as vitamin D, corticosteroids, or bisphosphonates, were excluded.

Overall, 170 eligible participants who visited the physical medicine and rehabilitation outpatient clinic were enrolled the study, and 162 of those expressed willingness to participate. To confirm their eligibility, a physical medicine and rehabilitation specialist conducted a detailed evaluation of these participants, which included a medical history review, physical examination, and imaging methods as X-ray and magnetic resonance imaging. After a thorough evaluation, the final analysis comprised 157 patients (Figure 1). The research adhered to the principles outlined in the Declaration of Helsinki. After receiving detailed information, the patients gave their written informed consent.

The patients' demographic information along with data regarding chronic conditions, including hypertension (HT), diabetes mellitus (DM), and coronary artery disease (CAD) were documented. Body mass index (BMI) was established using the height and weight measurements [13]. An assessor (a specialist physician) blinded to the study conducted all the assessments.

Blood samples were obtained by nurses working at Fatih Sultan Mehmet Training and Research Hospital for the analysis of serum 25-hydroxyvitamin-D [25(OH)D], the most reliable marker for assessing vitamin D levels. The 25(OH)D levels were evaluated using chemiluminescent microparticle immunoassay using the Architect i2000SR Immunoassay Analyzer (Abbott). Vitamin D levels of ≥30 ng/mL were classified as sufficient, 21–29 ng/mL as insufficient, and ≤20 ng/mL as deficient [14]. Accordingly, the participants were separated into two groups: vitamin D level of >20 ng/mL group and vitamin D level of ≤20 ng/mL group.

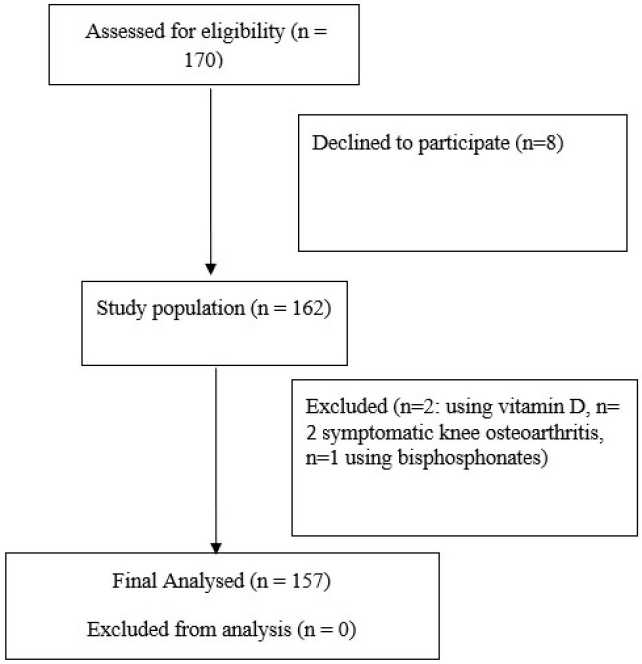

Figure 1. Flow diagram of participation.

The participants' resting, activity, and night pain levels were recorded with the visual analog scale (VAS), neuropathic pain using Douleur Neuropathic 4 (DN4), functional abilities using the Oswestry Disability Index (ODI), and quality of life using the 36-item Short-Form Health Survey (SF-36).

Pain Assessment: The VAS is a one-dimensional scale employed to assess pain severity. It is a 10-point scale. One end of the scale is designated with "no pain" and the other end with "the worst pain imaginable". The patient indicates their pain level by placing a mark on the scale [15].

Neuropathic pain: DN4 is a 10-question scale developed to measure neuropathic pain. Seven questions address symptoms of neuropathic pain. The remaining three questions are assessed through clinical examination. DN4 determines whether the sensation of touch or pins and needles decreases during examination (hypoesthesia), and whether light brushing increases or causes pain (allodynia). A score of 1 is given for each "Yes" response, whereas a score of 0 is assigned for each "No" response. A total score of ≥4 suggests the pain might be of neuropathic origin [16]. The DN4 is recognized as a dependable and accurate instrument for evaluating neuropathic pain among the Turkish population [17].

Function: The ODI comprises ten questions concern-

ing pain severity, personal care, lifting, walking, sitting, standing, sleeping, sexual activity, social interactions, and travel. It measures the functional abilities of individuals with lower back pain. The scale is categorized into five levels, with higher scores indicating poorer functional status [18]. It has been recognized as a valid and dependable instrument for evaluating disability in the Turkish population [19].

Quality of Life Assessment: The SF-36 comprises 36 questions about physical function, social functioning and mental health. A higher score signifies improved health [20]. The SF-36 has been recognized in previous studies as a valid and reliable tool in the Turkish population [21].

Statistical analysis

All statistical evaluations were completed with the aid of SPSS (version 27.0). Normally distributed values were defined as mean ± SD, nonnormally distributed values were defined as median (min- max), and categorical variables were defined as frequency and percentage. The Shapiro–Wilk test was employed to evaluate the normality of the data distribution. Moreover, the independent sample t-test was utilized. For quantitative independent data with a normal distribution, and the Mann–Whitney U test was used for data that do not follow a normal distribution. The chi-squared test was employed to analyze qualitative independent data.

Results

The participants had an average age and BMI of 54.2 ± 13.3 years and 28.5 ± 4.8 kg/m^2, respectively. Table 1 displays the demographic details of the study participants. Majority of participants (77.1%) were women, of whom 42.0% were housewives. Furthermore, nearly half of the participants (40.8%) were at least primary school graduates.

The mean duration of pain and vitamin D level were 59.0 ± 82.2 months, 22.0 ± 10.9 ng/mL respectively. Moreover, the mean VAS-resting, VAS-activity, VAS-night pain, DN4, and ODI scores of the entire cohort were 4.4 ± 2.5, 7.6 ± 2.0, 3.7 ± 3.6, 2.0 ± 2.1, and 32.4 ± 18.4, respectively. Table 2 provides a summary of the participants' clinical characteristics.

The vitamin D level of ≤20 ng/mL and vitamin D level of >20 ng/mL groups were statistically compared in terms of sociodemographic characteristics, such as age, BMI, frequency of comorbidities (including HT, DM, and CAD), occupation (civil servant, worker, retired, or student), alcohol use, and smoking status. Furthermore, the vitamin D level >20 ng/mL group had markedly higher educational level ($p<0.05$) and lower percentage of smokers ($p<0.05$) than the vitamin D level ≤20 ng/mL group (Table 3).

Table 4 illustrates the distribution of the groups based on clinical characteristics. The group with vitamin D levels of >20 ng/mL had significantly lower scores on both VAS-resting and VAS-activity relative to the group with vitamin D levels of ≤20 ng/mL ($p<0.05$). Conversely, no meaningful disparity was detected in VAS-night pain scores between the two groups ($p>0.05$).

Table 1. Demographic parameters of participants.

	Min-Max	Median	Medium ± SD	n (%)
Age	20.0 - 75.0	57.0	54.2 ± 13.3	
Sex				
Female			121	77.1%
Male			36	22.9%
BMI	19.7 - 43.0	27.7	28.5 ± 4.8	
Education				
Illiterate			14	8.9%
Primary school			64	40.8%
Secondary school			17	10.8%
High school			31	19.7%
University			31	19.7%
Occupation				
Housewife			66	42.0%
Retire			43	27.4%
Student			3	1.9%
Civil servant			11	7.0%
Worker			34	21.7%
Smoking				
Never smoking			92	58.6%
Prevus smoking			25	15.9%
Smoking			40	25.5%
Alcohol habit				
None			140	89.2%
Less than once a month			17	10.8%
HT			100	63.7%
DM			119	75.8%
CAD			134	85.4%
Diagnosis				
Non-spesific low back pain			50	31.8%
Lumbar disc herniation			35	22.3%
Sacroiliac disfunction			23	14.6%
Lumber spondylosis			24	15.3%
Lumber spinal stenosis			19	12.1%
Spondylolisthesis			5	3.2%
Maigne syndrome			2	1.3%

BMI: Body mass index, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronery artery disease.

Discussion

In the present study, participants with vitamin D levels >20 ng/mL were older than those with ≤20 ng/mL. The VAS-rest and VAS-activity scores were significantly lower in the group with vitamin D levels >20 ng/mL. However, no notable differences in VAS-night pain scores, DN4 scores, pain duration, disability, or quality of life were observed between the groups.

Numerous studies that examined the relationship in comparison vitamin D and chronic low back pain have yielded conflicting outcomes. Aligned with our findings, majority of the studies have found no meaningful link across vita-

Table 2. Clinical features of participants.

	Min-Max	Median	Medium ± SD	n (%)
Leg pain				
Yes			95	60.5%
No			62	39.5%
Pain duration	1.0 - 360.0	24.0	59.0 ± 82.2	
D Vitamin	3.0 - 58.5	21.0	22.0 ± 10.9	
VAS Score				
Rest	0.0 - 10.0	5.0	4.4 ± 2.5	
Activity	0.0 - 10.0	8.0	7.6 ± 2.0	
Night	0.0 - 10.0	3.0	3.7 ± 3.6	
DN4 Score	0.0 - 8.0	1.0	2.0 ± 2.1	
Physical function	5.0 - 100.0	55.0	55.6 ± 23.5	
Role limitations due to physical health	0.0 - 100.0	25.0	38.7 ± 39.9	
Role limitations due to emotional problems	0.0 - 100.0	33.3	41.2 ± 42.9	
Energy	0.0 - 90.0	45.0	42.4 ± 21.1	
Emotional well-being	10.0 - 96.0	52.0	53.9 ± 19.5	
Social function	0.0 - 100.0	62.5	57.1 ± 25.0	
Pain	0.0 - 100.0	35.0	38.0 ± 22.0	
General healthy	5.0 - 90.0	45.0	45.1 ± 20.0	
ODI score	0.0 - 90.0	30.0	32.4 ± 18.4	
Minimal disability			48	30.6%
Moderate disability			57	36.3%
Severe disability			43	27.4%
Disabled			5	3.2%
Bedridden			4	2.5%

VAS: Visual analog scale, DN4: Douleur Neuropathic 4 Questions, ODI: Oswestry disability index.

Table 3. Distribution of D vitamin level to demographic characteristics of the participants.

	Vitamin D levels ≤ 20 (n=73)		Vitamin D levels > 20 (n=84)		p
	I.Q-3.Q	Median	I.Q-3.Q	Median	
Age	42.5 - 63	51.0	50.0 - 65	58.5	**0.016**^{m}
Sex					
Female	55 75.3%		66 78.6%		0.631$^{x^2}$
Male	18 24.7%		18 21.4%		
BMI	25.3 - 31.6	28.4	25.3 - 31.5	27.5	0.774 m
Education					
Illiterate	10 13.7%		4 4.8%		
Primary school	33 45.2%		31 36.9%		
Secondary school	11 15.1%		6 7.1%		**0.006**$^{x^2}$
High school	12 16.4%		19 22.6%		
University	7 9.6%		24 28.6%		
Occupation					
Housewife	37 50.7%		29 34.5%		
Retire	16 21.9%		27 32.1%		
Student	0 0.0%		3 3.6%		0.774$^{x^2}$
Civil servant	3 4.1%		8 9.5%		
Worker	17 23.3%		17 20.2%		
Smoking					
Never smoking	41 56.2%		51 60.7%		
Prevus smoking	7 9.6%		18 21.4%		**0.021**$^{x^2}$
Smoking	25 34.2%		15 17.9%		
Alcohol habit					
None	67 91.8%		73 86.9%		0.327$^{x^2}$
Less than once a month	6 8.2%		11 13.1%		
HT	49 67.1%		51 60.7%		0.405$^{x^2}$
DM	57 78.1%		62 73.8%		0.533$^{x^2}$
CAD	62 84.9%		72 85.7%		0.890$^{x^2}$

^{m}: Mann-whitney u test / $^{x^2}$: Chi-square test Q: quartile, BMI: body mass index, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronery artery disease.

min D levels and chronic low back pain concerning factors such as sex, BMI, and occupation [10,12,22-26]. The results on age were quite contrasting. While many studies have not identified a connection across age and vitamin D deficiency [10,22-26], in our analysis, the average age of the vitamin D level >20 ng/mL group was higher.

Contrary to studies that did not find a connection in comparison to educational level and vitamin D [10,23,26], our study found that the vitamin D level >20 ng/mL group had higher educational level. This could be attributed to the greater awareness about vitamin D with the increase in the level of education.

Few studies have explored how smoking and alcohol use influence the link in relation to vitamin D and chronic low back pain. Xu et al. found no notable difference in this association in terms of smoking status or alcohol use [25]. In our study, although the number of patients who consumed alcohol was quite low and no differences were observed between groups, the proportion of smokers was significantly lower in the vitamin D level >20 ng/mL group than the other group. This finding suggests that smoking, which is recognized as a contributing factor to low back pain [1], negatively impacts vitamin D levels.

Some research has revealed a significant correlation in relation to vitamin D deficiency and severe pain compared with mild pain [10,23,24,27], whereas others have found no such association [12,22,28]. In our study, individuals with higher vitamin D levels experienced lower pain levels at rest and during activity.

Research conducted in the Middle East/Mediterranean region involving women has found a strong link across vitamin D deficiency and low back pain. Contrarily, studies conducted outside this region generally found no such association. These discrepancies have been attributed to several factors, such as climate differences, sun exposure, clothing preferences, and obesity [4]. However, our study, despite being conducted in the same region, found no gender differences.

Several researches did not detect linking across vitamin D level and neuropathic pain [29,30], whereas others have

Table 4. Distribution of vitamin D according to clinical characteristics of the participants.

	Vitamin D levels ≤ 20 (n=73)		Vitamin D levels > 20 (n=84)		p
	I.Q-3.Q	Median	I.Q-3.Q	Median	
Leg pain					
Yes	49 67.1%		46 54.8%		0.114[x²]
No	24 32.9%		38 45.2%		
Pain duration	4.0 - 66.6	12.0	7.5 ± 96.0	24.0	0.231[m]
VAS Score					
Rest	3.0 - 6.0	5.0	2.0 - 6.0	4.5	**0.045[m]**
Activity	7.0 - 10.0	8.0	6.0 - 9.0	8.0	**0.012[m]**
Night	0.0 - 8.0	3.0	0.0 - 6.0	3.0	0.531[m]
DN4 Score	2.3 ± 2.2	2.0	1.8 ± 2.0	1.0	0.142[m]
Physical function	37.5 - 70.0	55.0	46.3 - 75.0	60.0	0.095[m]
Role limitations due to physical health	0.0 - 75.0	25.0	0.0 - 75.0	25.0	0.640[m]
Role limitations due to emotional problems	0.0 - 100.0	33.3	0.0 - 100.0	33.3	0.45[m]
Energy	25.0 - 60.0	45.0	26.3 - 55.0	45.0	0.845[m]
Emotional well-being	42.0 - 64.0	52.0	40.0 - 71.0	56.0	0.580[t]
Social function	37.5 - 75.0	50.0	40.6 - 75.0	62.5	0.077[m]
Pain	22.5 - 46.3	35.0	22.5 - 47.5	35.0	0.532[m]
General healthy	25.0 - 62.5	45.0	30.0 - 60.0	45.0	0.709[m]
ODI score	20.0 - 46.0	32.0	17.8 - 44.0	29.5	0.123[m]
Minimal disability	21 28.8%		27 32.1%		0.194[x²]
Moderate disability	24 32.9%		33 39.3%		
Severe disability	21 28.8%		22 26.2%		
Disabled	4 5.5%		1 1.2%		
Bedridden	3 4.1%		1 1.2%		

[t]: Independent samples t-test / [m]: Mann-whitney u test / [x²]: Chi-square test, Q: quartile, VAS: Visual analog scale, DN4: Douleur Neuropathic 4 Questions, ODI: Oswestry disability index.

reported that vitamin D is beneficial in alleviating neuropathic pain [31]. In our research, no notable difference was observed across vitamin D level and neuropathic pain scores. This lack of association could be attributed to the low prevalence of neuropathic pain complaints among the participants (mean DN4 score of 2.0 ± 2.1). More extensive studies investigating the influence of vitamin D levels on neuropathic pain accompanied with chronic low back pain are warranted.

Duration of pain is another parameter that has been less explored in relation to the connection between vitamin D and low back pain. Çalık et al. observed vitamin D levels diminished with the length of pain duration [12]. However, in our study, no notable link was observed across pain duration and vitamin D, consistent with the research by Johansen et al [22]. The average duration of pain in the study by Çalık et al. was 14.23 ± 6.57 months [12], whereas in our study, it was 59.0 ± 82.2 months, which was considerably longer.

In our study, no relationship was beheaded in comparison to vitamin D levels and disability scores, which aligns with the results reported by Kim et al [10]. However, Çalık et al. [12] found lower functional abilities in participants with low vitamin D levels.

The link across vitamin D level and quality of life in patients with low back pain has not been sufficiently investigated in the academic sources. Suboptimal Vitamin D have been shown to reduce patients' quality of life by affecting their physical functions, vitality, energy level, and social functions [32]. In a study conducted in the Korean population, no association was found across vitamin D and health-related quality of life, except for depression and anxiety [33]. In our study, no connection was identified linking vitamin D level and quality of life.

Studies that found a link across vitamin D and low back pain have demonstrated the efficacy of low-cost and low-side-effect vitamin D supplementations in managing of low back pain [10,23,24,27]. There are reviews showing the superiority of vitamin D to placebo in the management of chronic musculoskeletal pain [34,35]. Several mechanisms have been investigated to explain how vitamin D affects pain. One of these mechanisms is that vitamin D increases bone mineral density in patients experiencing low back pain due to osteoporosis or vertebral fractures [7]. Another mechanism reported in the literature is that vitamin D induces an analgesic impact by reducing proinflammatory cytokines and increasing anti-inflammatory cytokines [8]. Although our study reported the influence of vitamin D on pain, there are studies that have not established the superiority of vitamin D to placebo in the handling of chronic low back pain [36-38]. Although these studies

reported that vitamin D treatment alone cannot be a miracle cure for low back pain, we cannot ignore the fact that vitamin D levels still affect pain levels in patients with the aforementioned condition. All physicians dealing with patients having chronic low back pain should take into account the negative effects of vitamin D levels on pain when evaluating the patients' risk factors.

The current research has certain limitations. Only one vitamin D sample was taken from the participants. A small of number of participants is another limitation. Another limitation is that the participants were not classified according to etiology because the numbers in the group would be too small. Extended, controlled studies with larger participant numbers that would include muscle strength and ultrasound imaging assessment of the low back muscles are needed to determine causality between vitamin D and chronic low back pain.

Conclusion

The results of this study revealed differences across vitamin D deficiency and chronic low back pain concerning age, educational level, smoking status, and pain level. These results indicated that vitamin D level in individuals suffering from chronic low back pain was correlated with young age, smoking habit, low educational level, and high pain intensity. Considering risk factors at the initial presentation of these patients, incorporating vitamin D supplementation when a deficiency is present could offer additional benefits.

Conflict of interest

The authors declare no conflicts of interest.

Ethical approval

The Ethics Committee of the University of Health Sciences granted approval for the study (24/272).

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