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# A study on the correlation between preoperative vitamin D levels and postoperative pain and quality of life in middle-aged and young patients with lumbar degenerative diseases

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**Abstract**: To investigate the correlation between preoperative vitamin D levels and postoperative pain and quality of life in young and middle-aged patients with lumbar degenerative disease (LDD). The 228 young and middle-aged LDD patients treated in Shanghai Sixth People's Hospital (China) between January 2022 and December 2023 were chosen for the research. The patients were categorized into an insufficient/deficient group as well as an adequate group on the basis of 25-(OH)D levels. Visual analogue scale (VAS), Japanese Orthopaedic Association (JOA) score, Oswestry disability index (ODI), and quality of life score (SF-12) of the two groups were compared, respectively. To assess the correlation between preoperative vitamin D and postoperative pain and quality of life in LDD patients. Preoperative 25-(OH)D was positively correlated with postoperative lumbar spine function and life quality, and negatively correlated with postoperative pain and ODI index ($P$<0.05). The results of multiple linear regression analysis showed that the serum 25-(OH)D level was the main influencing factor for postoperative pain and quality of life in patients with LDD. For every 1ng/mL increase in 25-(OH)D level, the VAS score decreased by 0.091 points and the quality of life score increased by 0.349 points. The lower the preoperative serum vitamin D level in LDD patients, the higher the risk of postoperative pain, the more serious the dysfunction of patients, and the worse the quality of life.

**Keywords**: Vitamin D; lumbar degenerative disease; postoperative pain; quality of life

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## INTRODUCTION

Lumbar degenerative disease (LDD) is a kind of syndrome caused by lumbar and leg degeneration, which can cause a variety of symptoms such as lower back pain, and leg pain, reduce patients' activity ability, and affect work and life (Aoki *et al*., 2020; Yasuhara *et al*., 2021). Presently, clinical treatment for patients with mild degenerative lumbar spine disease is mostly based on conservative treatment to reduce symptoms and relieve patients' pain. However, for patients with ineffective conservative treatment or severe symptoms, timely surgical treatment is still needed to rapidly improve lumbar function and remove the impact of the disease on life (Bamps *et al*., 2023; Hiyama *et al*., 2022). Vitamin D is a steroid derivative. Its main function is to regulate calcium and phosphorus metabolism (Chang and Lee, 2019; Delrue and Speeckaert, 2023). It is estimated that more than 1 billion people worldwide already have vitamin D deficiency or insufficiency (Amrein *et al*., 2020). Vitamin D deficiency in young people in China is also relatively serious (Fang *et al*., 2021). Related research suggests that vitamin D deficiency may be related to the prognosis of patients after spinal surgery. Among these adverse outcomes mainly include postoperative quality of life decline, increased risk of pseudojoint, and functional nervous system decline (Xu *et al*., 2020).

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However, at present, there are few studies on vitamin D levels and postoperative outcome indicators of LDD patients at home and abroad, and the correlation between the two is not clear in young and middle-aged LDD patients. Based on this, this study selected middle-aged and young LDD patients as the research objects, investigated their vitamin D levels and analyzed their relationship with postoperative outcome indicators to provide a basis for future interventional studies.

## MATERIALS AND METHODS

### *General information*

The 228 young and middle-aged LDD patients treated in Shanghai Sixth People's Hospital (China) between January 2022 and December 2023 were chosen for the research. Inclusion criteria: (1) Patients with a definite diagnosis of LDD; (2) Conservative treatment failed for 3 months and surgical treatment was proposed; (3) Age 18-59 years old; (4) Good language expression and understanding ability; (5) Patients were informed and volunteered to participate in this research. Exclusion criteria: (1) Patients with other serious diseases or complications (such as malignant tumors, severe liver and kidney damage, etc.); (2) Patients who do not perform surgical treatment as planned; (3) Unable to complete 3 months of interview. In previous similar studies, the correlation coefficient between preoperative vitamin D levels and postoperative indicators such as pain and quality of life was approximately 0.3. The significance

level (α) of the hypothesis test was set at 0.05 and the statistical power (1-β) was set at 0.8. The formula for calculating the sample size is as follows:

$$n = (\frac{Z_{\alpha/2} + Z_{\beta}}{r})^2 \times 2$$

Among them, $Z_{\alpha/2}$=1.96, $Z_{\beta}$=0.84 and n=174 is calculated. Considering that there is a 10% loss to follow-up and refusal to visit, at least 191 research subjects are included. A total of 229 patients were finally included in this study.

***Serum vitamin D detection***

Before the operation, 3 ml of serum was extracted from the observation subjects. Vitamin D level in serum was detected using Applied Biosystems' high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) instrument. Vitamin D levels are divided into three levels: 25- (OH) D deficiency: <20 ng/ml; insufficiency: 20-30 ng/ml; sufficiency: ≥30 ng/ml. Patients with preoperative vitamin deficiency or insufficiency were included in the "insufficient/deficient group" and patients with preoperative vitamin sufficiency were included in the "adequate group".

***Observation index***

(1) Demographic data: gender, age, education level, drinking and smoking. (2) Clinical data: LDD course, surgical methods, types of lumbar degeneration, etc. (3) Lumbar function: Three months after surgery, lumbar function was evaluated by the JOA score (Kato *et al*., 2015). It included 3 aspects: subjective symptoms (9 points), clinical signs (6 points), and limitation of daily activities (14 points). The total score is 29 points. The more points the higher the score, the better the lumbar spine function. (4) Postoperative pain score (Shafshak and Elnemr, 2021): 1 week after surgery, pain was evaluated by VAS. The total score ranged from 0 to 10, with lower scores indicating less pain. (5) Dysfunction: 3 months after surgery, the ODI (Aytekin *et al*., 2023) was used for evaluation, which has ten items, including pain degree, walking, weight lifting, sleeping, daily living, social life, etc. Each entry is scored from 0 to 5 points. ODI is calculated by dividing the sum of the ten scores by 50. Higher scores indicate more severe dysfunction. (6) Quality of life: 3 months after surgery, the evaluation was made according to the brief table of Quality of Life (SF-12) (Arovah and Heesch, 2021), including the two areas of physiology and psychology. Scores range from 0 to 100, with higher scores representing better quality of life.

***Ethical approval***

This study was approved by the Ethics Committee of Shanghai Sixth People's Hospital (2021-KY-51(k)).

## STATISTICAL ANALYSES

Statistical analyses were performed using the SPSS 22.0 software package. Measurement data were presented as mean ± standard deviation and independent t-tests were used for comparison between the two groups. Counting data were presented as cases (%), and comparisons between the two groups were made using the chi-square test. Correlation analysis was performed using Pearson correlation analysis. Influential factors were studied using multiple linear regression analysis. Differences were considered statistically significant at $P$<0.05.

## RESULTS

***Clinical data***

The average preoperative vitamin D level of 228 patients (22.95±8.24) ng/ml, preoperative vitamin D deficiency 98 cases (42.98%), vitamin D deficiency 54 cases (23.68%), vitamin D sufficiency 76 cases (33.33%). The patients were classified into insufficient/deficient group (152 cases) and adequate group (76 cases). In two groups of clinical data, such as the gender, and age, there was no statistically significant difference compared, as shown in table 1. The difference in 25-(OH)D, JOA score, VAS score, ODI score, and SF-12 score was statistically significant (P<0.05) when comparing the two groups (fig. 1).

***Correlation analysis***

According to Pearson correlation coefficient analysis, preoperative levels of 25-(OH)D were positively correlated with patients' postoperative lumbar spine function (JOA) and quality of life (SF-12), and negatively correlated with postoperative pain and ODI index (table 2).

***Influencing factors of postoperative pain in LDD patients***

Correlation analysis results showed that postoperative pain in LDD patients was negatively correlated with 25-(OH)D and lumbar function, and positively correlated with ODI index (table 3). The results showed that the serum 25-(OH)D level was the main influencing factor for postoperative pain in LDD patients, and the VAS score decreased by 0.091 points for every 1 ng/mL increase (table 4).

***Influencing factors of quality of life***

Correlation analysis results showed that the quality of life of LDD patients was positively correlated with 25-(OH)D and lumbar function, and negatively correlated with postoperative pain and ODI index (table 5). The multiple linear regression analyses indicated that serum 25-(OH)D level was the main influence on the quality of life of LDD patients, and its quality of life score increased by 0.349 points for every 1 ng/mL increase (fig. 2).

## DISCUSSION

The lumbar spine is the pivot of the human trunk and has many functions in the daily activities of the human body, such as load-bearing, cushioning shock and movement.

**Table 1**: Comparison of clinical data between the two groups of patients

| Variable | Adequate group (n=76) | Insufficient/deficiency group (n=152) | $\chi^2$/t | *P* |
|---|---|---|---|---|
| Gender | | | | |
| female | 49(64.47) | 86(56.58) | 1.308 | 0.253 |
| male | 27(35.53) | 66(43.42) | | |
| Age (yrs) | 46.74±7.63 | 46.56±6.40 | 0.175 | 0.862 |
| Education level | | | | |
| Junior high school and below | 23(30.26) | 53(34.87) | | |
| High school and technical secondary school | 22(28.95) | 43(28.29) | 0.537 | 0.765 |
| College or above | 31(40.79) | 56(36.84) | | |
| Smoking history | | | | |
| no | 50(65.79) | 88(57.89) | 1.322 | 0.250 |
| yes | 26(34.21) | 64(42.11) | | |
| Drinking history | | | | |
| no | 44(57.89) | 82(53.95) | 0.319 | 0.572 |
| yes | 32(42.11) | 70(46.05) | | |
| Surgical methods | | | | |
| Endoscopic minimally invasive decompression | 23(30.26) | 50(32.89) | 0.174 | 0.917 |
| Decompression with laminectomy | 27(35.53) | 51(33.55) | | |
| Decompression fusion internal fixation | 26(34.21) | 51(33.55) | | |
| Types of lumbar degeneration | | | | |
| Lumbar disc herniation | 20(26.32) | 41(26.97) | 1.046 | 0.790 |
| Lumbar spinal stenosis | 23(30.26) | 39(25.66) | | |
| Lumbar spondylolisthesis | 15(19.74) | 38(25.00) | | |
| Other types of degeneration | 18(23.68) | 34(22.37) | | |
| Duration of disease (month) | 19.76±5.05 | 19.32±4.45 | 0.674 | 0.501 |

**Table 2**: Correlation analysis of serum 25-(OH)D and each index

| Variable | r value | *P* value |
|---|---|---|
| Gender | -0.083 | 0.214 |
| Age | 0.043 | 0.518 |
| Education level | 0.029 | 0.665 |
| Smoking history | -0.065 | 0.331 |
| Drinking history | -0.018 | 0.789 |
| Duration of disease | 0.028 | 0.678 |
| Surgical methods | -0.020 | 0.761 |
| Types of lumbar degeneration | -0.055 | 0.407 |
| JOA | 0.730 | <0.001 |
| VAS | -0.625 | <0.001 |
| ODI | -0.486 | <0.001 |
| SF-12 | 0.655 | <0.001 |

Note: JOA: Japanese Orthopaedic Association; VAS: Visual Analogue Scale; ODI: Oswestry disability index; SF-12: Brief Table of Quality of Life

**Table 3**: Correlation analysis between postoperative pain and various indexes in LDD patients

| Variable | r value | *P* value |
|---|---|---|
| Gender | 0.085 | 0.200 |
| Age | 0.045 | 0.496 |
| Education level | 0.017 | 0.801 |
| Smoking history | -0.009 | 0.891 |
| Drinking history | 0.128 | 0.054 |
| Duration of disease | -0.122 | 0.065 |
| Surgical methods | 0.011 | 0.874 |
| Types of lumbar degeneration | 0.124 | 0.063 |
| 25-(OH)D | -0.625 | <0.001 |
| JOA | -0.584 | <0.001 |
| ODI | 0.436 | <0.001 |

**Table 4**: Multiple linear regression analysis of factors affecting postoperative pain in LDD patients

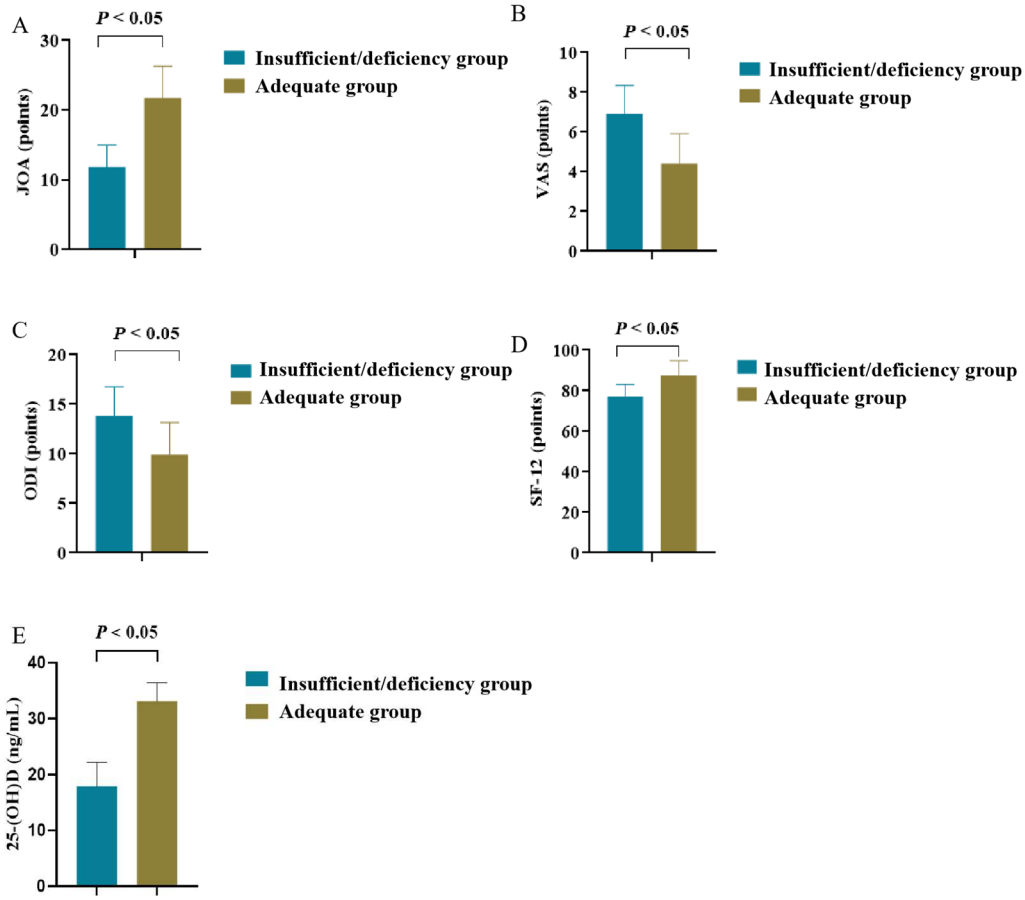
| Variable | B | SE | Beta | *t* value | *P* value | 95%CI |
|---|---|---|---|---|---|---|
| 25-(OH)D | -0.091 | 0.017 | -0.398 | -5.327 | <0.001 | [-0.124,-0.057] |
| JOA | -0.072 | 0.024 | -0.230 | -3.006 | <0.001 | [-0.120,-0.025] |
| ODI | 0.065 | 0.032 | 0.122 | 2.044 | 0.042 | [0.002,0.127] |

Note: JOA: Japanese Orthopaedic Association; ODI: Oswestry disability index

**Table 5**: Correlation analysis between LDD patients' quality of life and various indicators

| Variable | r value | *P* value |
|---|---|---|
| Gender | 0.011 | 0.864 |
| Age | 0.045 | 0.499 |
| Education level | -0.079 | 0.236 |
| Smoking history | -0.022 | 0.744 |
| Drinking history | -0.010 | 0.879 |
| Duration of disease | 0.106 | 0.111 |
| Surgical methods | -0.068 | 0.303 |
| Types of lumbar degeneration | 0.007 | 0.917 |
| 25-(OH)D | 0.655 | <0.001 |
| JOA | 0.610 | <0.001 |
| VAS | -0.538 | <0.001 |
| ODI | -0.484 | <0.001 |

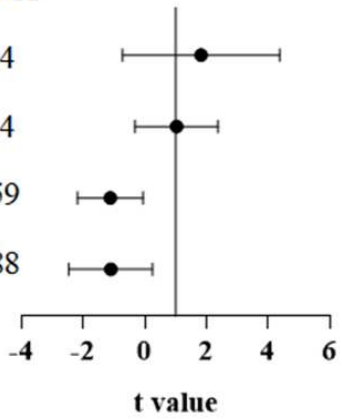
Note: JOA: Japanese Orthopaedic Association; VAS: Visual Analogue Scale; ODI: Oswestry disability index




Note: A: Comparison of the scores of the Japanese Orthopaedic Association (JOA) between the two groups of patients; B: Comparison of Visual Analogue Scale (VAS) scores between the two groups of patients; C: Comparison of the Oswestry disability index (ODI) scores of the two groups of patients; D: Comparison of the Short Form 12 (SF-12) scores of the two groups of patients; E: Comparison of 25-(OH)D levels between the two groups of patients

**Fig. 1**: Comparison of 25-(OH)D, JOA, VAS, ODI and SF-12 between the two groups

| Variable | B | SE | Beta | t | *P* | 95%LCI | 95%UCI |
|---|---|---|---|---|---|---|---|
| 25-(OH)D | 0.349 | 0.073 | 0.357 | 4.759 | <0.001 | 0.205 | 0.494 |
| JOA | 0.256 | 0.100 | 0.189 | 2.562 | 0.011 | 0.059 | 0.454 |
| VAS | -0.595 | 0.272 | -0.138 | -2.189 | 0.030 | -1.131 | -0.059 |
| ODI | -0.344 | 0.130 | -0.151 | -2.649 | 0.009 | -0.600 | -0.088 |




Note: JOA: Japanese Orthopaedic Association; VAS: Visual Analogue Scale; ODI: Oswestry disability index

**Fig. 2**: Forest map of multiple linear regression analysis of factors affecting quality of life of LDD patients

With the continuous growth of age, the intervertebral disc, vertebrae, and ligaments can appear a certain degree of natural aging and long-term lack of exercise can accelerate the aging process of the lumbar spine. In the long run, there may be pathological changes such as disc withdrawal, spinal canal stenosis, and other pathological changes.

Not only can it induce symptoms such as low back pain and lumbar leg pain, but it can also reduce lumbar spine stability and affect lumbar spine function. LDD is a condition characterized by progressive damage to the intervertebral disc and facet articular cartilage that affects the biomechanical properties of the spine, leading to damage to the joint capsule and ligament system. LDD is mainly caused by intervertebral disc degeneration. The main clinical manifestations of LDD include lumbar spinal stenosis, lumbar disc herniation, etc. It is mostly found in middle-aged and elderly people. The most significant impact of LDD on patients is pain (Hauser *et al*., 2022), which is usually aggravated during exercise and even causes damage to nerve function. Surgery is an important treatment for lumbar degenerative diseases. Compared with conservative treatment, it is effective, can quickly relieve symptoms, and promotes the recovery of lumbar function. However, 20%-30% of patients still have problems that the postoperative symptom relief is not obvious, functional recovery as well as improvement of life quality cannot reach the expected goal, and serious cases even need to be treated with another surgery (Bogaert *et al*., 2022). Thus, it is clinically important to explore a safe and effective approach to improve postoperative clinical outcomes in young and middle-aged patients with LDD.

The bone condition of human bones is the most important and direct factor that affects the reliability of lumbar internal fixation and the success of lumbar fusion. Vitamin D, as one of the calcium regulatory hormones, has an important influence on processes such as proliferation and differentiation of osteoblasts and has an important role in bone growth and bone density maintenance (Tan *et al*., 2020; Charoenngam and Holick, 2020). A related finding was that vitamin D deficiency is linked to a high risk of cervical disc herniation (Stepanov *et al*., 2020). This research indicated that the vitamin D-sufficient group had lower VAS scores at 1 week postoperatively and ODI scores at 3 months postoperatively, and higher lumbar JOA scores and quality of life scores (all P<0.05). And patients' preoperative vitamin D was positively associated with postoperative lumbar spine function and quality of life, and negatively associated with postoperative pain and ODI index. This result suggests that there is a clear correlation between the preoperative vitamin D level of patients with lumbar degenerative diseases and postoperative outcome indicators such as postoperative pain and quality of life. Hu *et al*. (Hu *et al*., 2022) found that preoperative vitamin D deficiency in patients would lead to a decrease in the fusion rate of lumbar fusion surgery. After continuous vitamin D supplementation for 3 months and a one-year follow-up, the postoperative ODI and postoperative pain of patients decreased. It indicates that long-term adequate vitamin D levels may play an important role in maintaining lumbar spine function and reducing chronic pain. Khalooeifard (Khalooeifard *et al*., 2022) *et al*. pointed out that vitamin D deficiency can have a negative impact on the postoperative outcome of elective spinal fusion surgery, leading to an increase in ODI and stated that optimizing vitamin D levels before surgery on the impact of clinical outcomes and improving prognosis is of great significance. The probable reason is that vitamin D regulates calcium and phosphorus metabolism and increases the body's use of phosphorus. It saturates plasma calcium and phosphorus levels and promotes normal bone growth and skeletal calcium (Donnally *et al*., 2019; Biczo *et al*., 2020). In addition, vitamin D can also

promote the absorption of calcium in the intestine, which increases the reabsorption of phosphorus through the renal tubules, correcting the symptoms of hypocalcemia in patients, and thus maintaining the normal level of citrate in the blood (Fleet, 2022; Seijo *et al*., 2022). At the same time, it can also relieve muscle and bone pain in patients (Dechsupa *et al*., 2023). When the body is deficient in vitamin D, calcium and phosphorus metabolism disorders can cause calcium in the bone to move into the blood leading to osteoporosis, limb muscle atrophy, and reduced muscle strength. It seriously affects the human locomotor system and walking function, and also significantly increases the risk of pain and falls (Rojano-Ortega and Berral-de, 2023). Bajaj (Bajaj *et al*., 2023) showed that intramuscular injection of vitamin D after surgery could improve the postoperative lumbar function of patients, effectively relieve pain, and improve clinical efficacy. Baek *et al*. (Baek *et al*., 2023) demonstrated that preoperative malnutrition is a powerful predictor of adverse clinical outcomes after surgery. The possible reason is that the patient's diet lacks sufficient calcium and vitamin D, which may lead to insufficient vitamin D levels, thereby affecting bone health and postoperative recovery. In addition, insufficient protein intake may also affect muscle function and wound healing, and the recovery of muscle function is crucial for patients after lumbar spine surgery to regain their mobility.

## CONCLUSION

In summary, preoperative vitamin D levels are significantly correlated with lumbar function, dysfunction, postoperative pain, and quality of life in LDD patients. Postoperative pain can be relieved, lumbar spine function can be improved and quality of life can be enhanced by postoperative intramuscular vitamin D injections. However, this study still has certain limitations. Firstly, the number of included cases in this study was relatively small and the follow-up time was short. Evaluations were only conducted 1 week and 3 months after the operation, and the impact of vitamin D levels on the long-term prognosis of patients was not fully observed.

Future studies could extend the follow-up period to gain a deeper understanding of the continuous impact of vitamin D levels on recovery and long-term prognosis. Secondly, although the demographic and clinical variables among the groups were compared, other potential confounding factors that might affect vitamin D levels and postoperative recovery were not analyzed in depth. Subsequent studies can consider including potential factors and evaluate the relationship between vitamin D levels and postoperative recovery more accurately through methods such as multivariate analysis. Finally, this study was single-center and may have geographical limitations. Different racial, geographical, or lifestyle factors may affect the results of vitamin D levels and LDD. Therefore, caution should be exercised when extending the results of this study to other populations. In the future, multi-center and large-sample studies can be conducted to verify the universality of the research results.

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***Conflict of interest***

There is no conflict of interest.

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