Association of Dorsal Subcutaneous Fat Thickness, Paraspinal Muscle Fat Infiltration, Modic Changes, and Demographic Factors with Lumbar Disc Degeneration on Magnetic Resonance Imaging

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Citation : Ernes, A., M, I. K., & Muharam, N. R. S. V. P. D. 2026. Association of Dorsal Subcutaneous Fat Thickness, Paraspinal Muscle Fat Infiltration, Modic Changes, and Demographic Factors With Lumbar Disc Degeneration on Magnetic Resonance Imaging. *Medicinus*, 15(3), 45–50.
Keywords : lumbar disc degeneration; dorsal subcutaneous fat thickness; paraspinal muscle; Modic changes; MRI
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Online First : 23 June 2026

Abstract

Background:

Lumbar disc degeneration is a common contributor to chronic low back pain. Magnetic resonance imaging enables assessment of disc degeneration and related factors, including dorsal subcutaneous fat thickness, paraspinal muscle fat infiltration, Modic changes, age, and sex.

Methods:

This quantitative cross-sectional study used consecutive sampling of patients who underwent non-contrast lumbar MRI at Royal Prima General Hospital, Medan, from September to November 2025. A total of 253 samples were analyzed. Lumbar disc degeneration was graded using the modified Pfirrmann system, paraspinal fat infiltration using the Goutallier classification, and Modic changes using standard MRI criteria. Statistical analysis was performed using SPSS.

Result:

Lumbar disc degeneration tended to be more severe in the lower lumbar levels, particularly L4-L5 and L5-S1. Paraspinal muscle fat infiltration, Modic changes, and age showed significant associations with lumbar disc degeneration. Dorsal subcutaneous fat thickness and sex did not show significant associations with degeneration across the analyzed levels.

Conclusions:

Paraspinal muscle fat infiltration, Modic changes, and age were significantly associated with lumbar disc degeneration on MRI, whereas dorsal subcutaneous fat thickness and sex were not. These findings support careful MRI evaluation of paraspinal muscle quality and endplate changes in patients with lumbar degeneration.

Introduction

Lower back pain (LBP) is a major musculoskeletal condition that affects quality of life and is recognized as an important cause of disability worldwide. LBP may be acute, subacute, or chronic according to symptom duration, and chronic LBP remains a significant clinical and public-health problem. Lumbar disc degeneration is one of the causes of chronic LBP and is characterized by degenerative wear and tear of the intervertebral disc.

The pathogenesis of lumbar disc degeneration is multifactorial and involves structural, cellular, and metabolic changes in the intervertebral disc. Magnetic resonance imaging (MRI) is the preferred modality for evaluating lumbar disc degeneration and related abnormalities because it provides multiplanar assessment of discs, vertebral endplates, and paraspinal soft tissues.

Previous studies have suggested that lumbar disc degeneration may be related to dorsal subcutaneous fat thickness, paraspinal muscle fat infiltration, Modic changes, age, and sex. However, the number of studies evaluating these variables remains limited, and some findings have been inconsistent. In Indonesia, MRI-based evidence evaluating these factors together is still scarce.

Therefore, this study aimed to analyze the association of dorsal subcutaneous fat thickness, fat infiltration of the paraspinal muscles, Modic changes, age, and sex with lumbar disc degeneration using non-contrast lumbar MRI.

Material And Methods

This study was an analytic quantitative study with a cross-sectional design. The study was conducted from September to November 2025 at Royal Prima General Hospital, Medan, Indonesia. The inclusion criterion was patients who underwent lumbar MRI examination at the hospital during the study period. Exclusion criteria were MRI artifacts, previous surgery in the lumbar region, metastatic lesions, congenital abnormalities, and infection involving the lumbar region.

The study included six variables: five independent variables consisting of dorsal subcutaneous fat thickness, paraspinal muscle fat infiltration, Modic changes, age, and sex; and one dependent variable, lumbar disc degeneration. The minimum sample size was calculated using a hypothesis test for two population means, and the required minimum was 176 samples. Consecutive-quota sampling was used, and 253 samples were included in the final analysis.

Data were obtained from Zetta PACS and electronic medical records. All participants underwent lumbar MRI using a 0.5 Tesla MRI system (Magnetom Free Max, Siemens). Imaging was performed in the supine position using a multichannel phased-array spine surface coil. The sequences included sagittal T1, sagittal T2, sagittal STIR T2, axial T2, and coronal T2 turbo spin-echo sequences.

Lumbar disc degeneration was evaluated from L1-L2 to L5-S1 using the modified Pfirrmann grading system on T2-weighted mid-sagittal images. Grades I-III were categorized as normal-mild, grades IV-V as moderate, and grades VI-VIII as severe. Dorsal subcutaneous fat thickness was measured on mid-sagittal T2-weighted images from the dorsal subcutaneous fat to the skin. Paraspinal muscle fat infiltration of the multifidus, erector spinae, and psoas muscles was assessed on axial T2-weighted images using the Goutallier classification and categorized as absent-mild or moderate-severe. Modic changes were assessed on T1- and T2-weighted sagittal images.

Data were analyzed using SPSS. Categorical variables were compared using the chi-square test or Fisher exact test. Non-parametric continuous variables were compared using the Mann-Whitney U test or Kruskal-Wallis test, depending on the number of groups compared. A p-value <0.05 was considered statistically significant.

Result

A total of 253 samples were analyzed, consisting of 163 females and 90 males. Lumbar disc degeneration was evaluated at five intervertebral disc levels from L1-L2 to L5-S1. The distribution of degeneration severity and mean modified Pfirrmann grade by level is shown in Table 1.

Table 1. Lumbar Disc Degeneration Distribution and Modified Pfirrmann Mean Value by Level

Level	Normal-mild n (%)	Moderate n (%)	Severe n (%)	Mean Pfirrmann grade
L1-L2	157 (62.1)	75 (29.6)	21 (8.3)	3.474
L2-L3	131 (51.8)	87 (34.4)	35 (13.8)	3.710
L3-L4	113 (44.7)	107 (42.3)	33 (13.0)	3.890
L4-L5	80 (31.6)	126 (49.8)	47 (18.6)	4.209
L5-S1	105 (41.5)	98 (38.7)	50 (19.8)	4.028

Degeneration severity tended to increase toward the caudal lumbar levels. The highest mean Pfirrmann grade was observed at L4-L5, followed by L5-S1, indicating more pronounced degeneration in the lower lumbar spine.

Dorsal subcutaneous fat thickness did not differ significantly across lumbar disc degeneration severity groups at any analyzed level. By contrast, paraspinal muscle fat infiltration showed significant associations with lumbar disc degeneration across multiple muscle groups and levels. Modic changes were significantly associated with lumbar disc degeneration at all evaluated lumbar endplates. Age also showed significant differences across degeneration severity groups at all levels, whereas sex showed no significant association with lumbar disc degeneration.

Table 2. Summary of Associations With Lumbar Disc Degeneration

Variable	Main finding	Statistical result
Dorsal subcutaneous fat thickness	No significant difference across degeneration severity groups at L1-L2 to L5-S1.	All $p>0.05$
Paraspinal muscle fat infiltration	Significant association for multifidus bilaterally at all levels; erector spinae bilaterally at L1-L2 to L4-L5; psoas right at all levels; and psoas left at L1-L2 to L4-L5.	Mostly $p<0.05$
Modic changes	Significant association between Modic changes and degeneration severity at evaluated lumbar endplates.	$p<0.05$
Age	Older age was associated with greater degeneration severity at every disc level.	$p<0.001$ at all levels
Sex	No significant association between sex and degeneration severity from L1-L2 to L5-S1.	All $p>0.05$

Discussion

This study evaluated the association of dorsal subcutaneous fat thickness, paraspinal muscle fat infiltration, Modic changes, age, and sex with lumbar disc degeneration using non-contrast lumbar MRI. Three of the five tested hypotheses were supported. Paraspinal muscle fat infiltration, Modic changes, and age were significantly associated with lumbar disc degeneration, whereas dorsal subcutaneous fat thickness and sex were not significantly associated.

Dorsal subcutaneous fat thickness was not significantly associated with lumbar disc degeneration at any level in this study. This finding differs from several previous studies that reported associations between dorsal subcutaneous fat measurements and lumbar disc degeneration, particularly at upper lumbar levels. Differences in study population, MRI machine characteristics, sample size, measurement methods, and anatomical level may explain these discrepancies.

Paraspinal muscle fat infiltration showed a consistent association with lumbar disc degeneration. This finding supports previous reports linking degeneration severity with fatty changes in the multifidus and erector spinae muscles. Paraspinal muscles play an important role in spinal stability; therefore, fat infiltration may reflect impaired muscular support or a degenerative process occurring alongside disc degeneration. The association was generally strong in the posterior paraspinal muscles and was also observed in the psoas muscle at several levels.

Modic changes were significantly associated with lumbar disc degeneration at all analyzed lumbar endplates. This is consistent with the concept that endplate changes and disc degeneration are interrelated degenerative phenomena. In clinical radiology practice, identifying the type and location of Modic changes is important because these findings may be relevant to the underlying cause of LBP and may influence clinical interpretation.

Age was significantly associated with lumbar disc degeneration across all levels. Disc degeneration is a chronic, multifactorial, and largely irreversible process that tends to increase with age as biomechanical stress, microtrauma, and tissue changes accumulate. In contrast, sex was not significantly associated with degeneration severity in this study. The absence of a significant sex association may be influenced by population characteristics, unequal numbers of male and female participants, and other unmeasured factors.

The results highlight the importance of comprehensive MRI evaluation beyond the intervertebral disc alone. Assessment of paraspinal muscle quality and Modic changes may provide additional information in patients with lumbar degeneration and LBP. However, this study was cross-sectional, so causal relationships cannot be established. Future studies should include larger and more balanced samples, higher-field MRI where available, additional variables related to degeneration, and interobserver or intraobserver reliability evaluation.

Conclusion

This study found no significant association between dorsal subcutaneous fat thickness and lumbar disc degeneration. Paraspinal muscle fat infiltration, Modic changes, and age were significantly associated with lumbar disc degeneration on MRI. Sex was not significantly associated with lumbar disc degeneration. These findings support careful MRI evaluation of paraspinal muscle infiltration and Modic changes when assessing lumbar degenerative disease.

Acknowledgement

None.

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Author's Statement

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