Volume 3, Number 3, 2026

Pages 1301-1309

Bioscience Insights

ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)

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ASSESSMENT OF VERTEBRAL PATHOLOGIES ON MRI AND THEIR CORRELATION WITH AGE AND PSYCHOLOGICAL FACTORS

Huda Sultan[1], Laamia Altuf[2], Aleena Mumtaz[3], Nimra Zia[4], Sadaf Ayesha[5], Riffat Bibi[6], Muhammad Irshad-Ul-Haq[*7]

[1,3,4]BS Medical Imaging Technology, Riphah International University, Lahore, Pakistan
[2,5]Faculty of Rehabilitation and Allied Health Sciences, Riphah International University, Lahore, Pakistan
[6]PhD Scholar in Ultrasound, Baku Eurasian University, Azerbaijan
*[*7]Manager, Office of Research, Innovation and Commercialization (ORIC), Green International University, Lahore, Pakistan*

[*7]irshadfta1@gmail.com

[*7]**ORCID ID:** https://orcid.org/0009-0008-9671-1881

https://doi.org/10.5281/zenodo.23915867

Article Information

Article History

Received:	June 19, 2026
Revised:	August 19, 2026
Accepted:	September 07, 2026
Available Online:	October 02, 2026

Keywords:
Magnetic resonance imaging (MRI); Lumbar spondylosis; Vertebral pathologies; Degenerative changes; Comorbidities; Age; Psychological factors; Biopsychosocial approach.

Abstract

Objective: *To assess MRI-identified vertebral pathologies and their associations with age, while highlighting their potential clinical and psychosocial implications.*
Design: *Cross sectional study.*
Place: *Department of Radiology, Sir Ganga Ram Hospital Lahore,*
Duration: *3 months.*
Methodology: *A total of 164 patients aged 30-70 years who had back pain and confirmed vertebral pathologies by MRI were included in this study of a cross-sectional design and selected using convenient sampling. Patients who have severe spinal surgery, malignancy, chronic infection, metallic implants or pregnancy were excluded. MRI scanning was done with a 1.5-Tesla machine with T1 and T2-weighted sequences, and multiplanar imaging. The data were analyzed statistically using SPSS version 24. Chi-square and independent-samples t-tests were used to determine whether there were association between the vertebral pathologies, age and relevant clinical variables. Psychological variables were not measured directly in this study, but were included in the biopsychosocial context.*

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ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
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Results: *Compressive disc bulge was the most common (64.0%), degenerative changes (43.9%) and lumbar spondylosis (34.8%). There was a significant association between age and lumbar spondylosis and degenerative changes ($p < 0.001$). Selected pathologies were associated to diabetes, hypertension and smoking. But significant regional associations were also found.*

Conclusion: *Age and comorbidities were related to particular vertebral abnormalities. Further research is recommended using a biopsychosocial approach including the assessment of psychological factors.*

INTRODUCTION

The vertebral column is an essential part of the axial skeleton that provides structural support, mobility and protection to the spinal cord.[1] It is made up of vertebrae, intervertebral discs, facet joints, ligaments and paraspinal muscles. The discs, each with a gelatinous nucleus pulposus surrounded by the collagenous annulus fibrosis, act as shock absorbers that cushion axial loads and allow motion.[2]

Despite this complex structure, the spine is subject to pathological processes, particularly degenerative ones that increase with age and mechanical wear.[2] These include degenerative disc disease, facet joint arthropathy, spondylosis, spinal stenosis and vertebral compression fractures.[3] Degenerative disc disease, the commonest of these, is the progressive dehydration and degeneration of the intervertebral discs, leading to loss of disc height, disc bulging, spondylosis and possible nerve root compression.[3]

Vertebral pathologies are a major global health problem. A meta-analysis estimated that degenerative spine disease and low back pain affect about 266 million people worldwide every year (3.63% of the world population), with the highest incidence in Europe (5.7%) and the lowest in Africa (2.4%).[4] Low back pain, a frequent clinical marker of vertebral pathology, is a leading cause of years lived with disability in all age groups and regions, with marked effects on productivity and quality of life.[5,6]

Age-related degeneration begins as early as the third decade of life and progresses thereafter, so people aged 30–70 years are especially vulnerable. Discs become less hydrated and less elastic, and endplate sclerosis and osteophyte formation may develop, altering spinal biomechanics and producing symptomatic disease.[2]

Magnetic resonance imaging (MRI) is the standard modality for assessing vertebral disease, offering excellent soft-tissue contrast and multiplanar imaging without ionizing radiation.[7] It detects early degenerative changes such as disc dehydration, fissuring and herniation that may not be evident on X-ray or CT, and quantitative MRI techniques may further help evaluate subtle age-related degeneration.[7,8] This study therefore aimed to assess vertebral pathologies on MRI across age groups, to help distinguish normal age-related changes from clinically significant pathology and to support early, age-specific prevention and treatment.

Pathology of the vertebrae can be assessed through anatomical and radiological studies, but the clinical importance of vertebral pathologies goes beyond the assessment of anatomical abnormalities. The biopsychosocial model has come to be seen as a better representation of the chronic back pain experience and better means of understanding how biological, psychological and social factors interact. Anxiety, depression, emotional distress, fear avoidance and pain catastrophizing are psychological factors that can

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ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
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affect the experience of pain, functional abilities, coping, and chronic disability. In a systematic review of the literature, carried out by Hassan et al., the following psychological and behavioural domains were identified as important factors contributing to differences in chronic low back pain (CLBP): anxiety, depression, coping behaviours, fear avoidance and catastrophizing. [12]

In addition, in an umbrella review of 15 systematic reviews, Otero-Ketterer et al. found that emotional distress, pain intensity, disability, negative recovery expectations and pain catastrophizing were important prognostic factors that were associated with poorer long-term outcomes in patients with low back pain.[13] The results highlight the need for psychological assessments to be done in conjunction with a physical and radiological assessment. Addressing physical, psychological and social aspects are also important in the management of chronic primary low back pain. [14]

Methodology

This cross-sectional study was conducted in the Radiology Department of Sir Ganga Ram Hospital, Lahore, over three months. The sample size was calculated as $n = z^2 \cdot p(1-p)/d^2$, giving 164 patients, who were selected by convenient sampling. Data were collected through a questionnaire and informed consent form after approval from the hospital ethical committee.

MRI was performed on a 1.5 Tesla Toshiba scanner. The protocol comprised T1-weighted and T2-weighted axial and sagittal sequences, short tau inversion recovery (STIR), gradient echo (GRE) and diffusion-weighted imaging (DWI). Data were analysed with SPSS version 24 and Microsoft Excel 2016. Frequency and percentage were calculated for categorical variables and mean and standard deviation for quantitative variables. The t-test was used to evaluate the association between age and vertebral pathologies, and the chi-square test to evaluate the correlation of vertebral pathologies with spinal region, age group and comorbidities.

Inclusion Criteria

Patients of both genders aged 30–70 years who presented with back pain and had an MRI diagnosis of compressive disc bulge, non-compressive disc bulge, lumbar spondylosis, cervical spondylosis, radial annular tear or degenerative changes were included. Patients outside this age range, without back pain, or without an MRI-diagnosed vertebral pathology did not meet the inclusion criteria.

Exclusion Criteria

To keep the relationship between age and vertebral pathology as free of confounding as possible, and to ensure patient safety and image quality, the following patients were excluded:

- Previous major spinal surgery. Surgery alters the native anatomy and signal characteristics of the spine, so postoperative findings cannot be attributed to age-related change.
- Other systemic diseases, such as cancer or chronic infection, which may affect the spine and introduce changes that are not directly related to age.
- Metallic implants. These are a safety concern for MRI and a source of susceptibility artefact that degrades image quality.
- Pregnant women, who were excluded as a precaution in line with standard MRI screening practice.

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Patient Consent and Ethics

The study followed the rules and regulations of the ethical committee of Riphah International University, Lahore, and approval was obtained from the ethical committee of Sir Ganga Ram Hospital before data collection. Written informed consent was obtained from all participants. Participation was voluntary, participants could withdraw at any time without penalty, and confidentiality and anonymity were maintained throughout.

Results: A total of 164 patients were included, of whom 87 (53.0%) were male and 77 (47.0%) were female. According to patient history, 5 (3.0%) had a history of fever, 46 (28.0%) were diabetic, 47 (28.7%) were hypertensive and 53 (32.3%) were smokers (Table 1).Compressive disc bulge was the most frequent finding (n = 105; mean age 46.35 years), followed by degenerative changes (n = 72; 51.69 years), lumbar spondylosis (n = 57; 53.04 years), non-compressive disc bulge (n = 46; 49.11 years), radial annular tear (n = 30; 48.07 years) and cervical spondylosis (n = 9; 48.33 years) (Table 2).Patients were divided into four age groups (31–40, 41–50, 51–60 and 61–70 years; Tables 3 and 4). Lumbar spondylosis increased with age, particularly from 41 years onwards (χ^2 = 19.403, $p < 0.001$), and degenerative changes showed a strong significant correlation with age (χ^2 = 24.747, $p < 0.001$). Cervical spondylosis (χ^2 = 0.66, p = 0.882) and radial annular tear (χ^2 = 2.997, p = 0.392) showed no statistical correlation with age. Compressive disc bulge was non-significant on chi-square (χ^2 = 7.535, p = 0.057), and a correlation between age and non-compressive disc bulge was also reported (χ^2 = 2.702, p = 0.44). On the t-test, age was significantly associated with compressive disc bulge (p = 0.039), lumbar spondylosis ($p < 0.001$) and degenerative changes ($p < 0.001$), but not with cervical spondylosis (p = 0.89), non-compressive disc bulge (p = 0.381) or radial annular tear (p = 0.89) (Table 3).

Diabetes was significantly associated with compressive disc bulge (χ^2 = 5.626, p = 0.018) and degenerative changes (χ^2 = 26.889, $p < 0.001$); hypertension with lumbar spondylosis (χ^2 = 24.558, $p < 0.001$) and radial annular tear (χ^2 = 60.429, $p < 0.001$); and smoking with non-compressive disc bulge (χ^2 = 45.424, $p < 0.001$). The remaining combinations were not statistically significant (Table 5).

Cervical spondylosis was significantly associated with the cervical ($p < 0.001$) and lumbar ($p < 0.001$) regions; lumbar spondylosis with the thoracic (p = 0.024) and lumbar (p = 0.007) regions; radial annular tear with the thoracic region (p = 0.003); and compressive disc bulge with the lumbar region (χ^2 = 4.284, p = 0.038). Degenerative changes were not significantly associated with any region (cervical p = 0.965, thoracic p = 0.973, lumbar p = 0.495) (Table 6).

Table 1. Gender and comorbidities of the study population (N = 164)

Variable	Yes / Male, n (%)	No / Female, n (%)
Gender (male / female)	87 (53.0)	77 (47.0)
History of fever	5 (3.0)	159 (97.0)
Diabetes	46 (28.0)	118 (72.0)
Hypertension	47 (28.7)	117 (71.3)
Smoking	53 (32.3)	111 (67.7)

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Table 2. Frequency and mean age of vertebral pathologies (N = 164)

Vertebral pathology	n (%)	Mean age (years)	Std. deviation	Std. error mean
Compressive disc bulge	105 (64.0)	46.352	11.689	1.141
Degenerative changes	72 (43.9)	51.694	12.632	1.489
Lumbar spondylosis	57 (34.8)	53.035	12.050	1.596
Non-compressive disc bulge	46 (28.0)	49.109	12.641	1.864
Radial annular tear	30 (18.3)	48.067	11.991	2.189
Cervical spondylosis	9 (5.5)	48.333	12.884	4.295

Table 3. Association of vertebral pathologies with age (chi-square across four age groups, df = 3; independent t-test)

Vertebral pathology	n	Mean age ± SD	χ^2	p (χ^2)	t	p (t)	df (t)
Compressive disc bulge	105	46.35 ± 11.69	7.535	0.057	2.079	0.039	162
Lumbar spondylosis	57	53.04 ± 12.05	19.403	<0.001	−4.313	<0.001	162
Cervical spondylosis	9	48.33 ± 12.88	0.660	0.882	−0.139	0.89	162
Non-compressive disc bulge	46	49.11 ± 12.64	2.702	0.44	−0.879	0.381	162
Radial annular tear	30	48.07 ± 11.99	2.997	0.392	−0.138	0.89	162
Degenerative changes	72	51.69 ± 12.63	24.747	<0.001	−3.764	<0.001	137.2

Table 4. Number of patients with each pathology by age group (N = 164)

Age group (years)	n	CDB	LS	CS	NCDB	RAT	DC
31–40	57	40	10	3	14	13	18
41–50	52	35	16	2	14	8	15
51–60	30	20	16	2	12	3	22
61–70	25	10	15	2	6	6	17

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ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
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CDB, compressive disc bulge; LS, lumbar spondylosis; CS, cervical spondylosis; NCDB, non-compressive disc bulge; RAT, radial annular tear; DC, degenerative changes.

Table 5. Association of vertebral pathologies with comorbidities (χ^2 value, p-value)

Vertebral pathology	Diabetes	Hypertension	Smoking
Compressive disc bulge	5.626 (0.018)	0.472 (0.492)	0.001 (0.981)
Lumbar spondylosis	0.137 (0.712)	24.558 (<0.001)	0.307 (0.580)
Cervical spondylosis	1.354 (0.245)	0.102 (0.75)	1.958 (0.162)
Non-compressive disc bulge	0.001 (0.970)	1.497 (0.221)	45.424 (<0.001)
Radial annular tear	0.508 (0.476)	60.429 (<0.001)	0.090 (0.764)
Degenerative changes	26.889 (<0.001)	0.678 (0.410)	0.008 (0.928)

Table 6. Association of vertebral pathologies with spinal region (χ^2 value, p-value)

Vertebral pathology	Cervical	Thoracic	Lumbar
Compressive disc bulge	1.631 (0.202)	0.029 (0.865)	4.284 (0.038)
Lumbar spondylosis	3.557 (0.059)	5.073 (0.024)	7.345 (0.007)
Cervical spondylosis	58.378 (<0.001)	0.553 (0.457)	38.076 (<0.001)
Non-compressive disc bulge	0.528 (0.468)	1.354 (0.245)	0.378 (0.538)
Radial annular tear	0.493 (0.483)	8.846 (0.003)	0.018 (0.893)
Degenerative changes	0.002 (0.965)	0.001 (0.973)	0.466 (0.495)

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ISSN: 3080-3497 (Online)
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Discussion

This study assessed vertebral pathologies on MRI in 164 patients aged 30–70 years and examined their correlation with age and comorbidities. Lumbar spondylosis and degenerative changes were strongly correlated with age, whereas cervical spondylosis and radial annular tear showed no significant age correlation.

The main focus of the current investigation was on the structural abnormalities detected on MRI and their association with age; however back pain could also have psychological and behavioural dimensions which are not reflected by the structural abnormalities detected on MRI. Psychological distress, depressive symptoms, fear avoidance and pain catastrophizing have been shown to play a role in the chronic persistence of LBP and associated functional disability in previous studies.[12-13,15] Thus, radiological findings should not be the only basis for making a diagnosis of patients' overall pain experience, but rather must be looked at in conjunction with their clinical symptoms.

An understanding of the relationship between physical pathology, pain-related behavior and psychological well-being from a health psychology approach can be useful to inform a more holistic assessment of patients. The biopsychosocial approach acknowledges that biological dysfunction and psychological reactions and social factors have a synergistic effect on the experience and results of back pain.[13,14] The present study, however, failed to measure anxiety, depression, psychological distress and pain-related disability so direct conclusions cannot be drawn regarding these psychological factors.

Radial annular tear had no significant association with age ($p = 0.392$) but was significantly associated with the thoracic region ($p = 0.003$). Takatalo et al. found that 9.1% of their subjects had at least one radial tear, with no significant difference between genders, and that most tears were in the two lowest lumbar discs.9 That study analysed gender-based variables, whereas the present study analysed age-based variables.

Cervical spondylosis likewise showed no significant age correlation ($p = 0.882$), but was significantly associated with the cervical ($p < 0.001$) and lumbar ($p < 0.001$) regions. Tamai et al. reported that the cervical spondylosis ratio at C7 correlated with disc degeneration at C3–4, C4–5, C5–6 and C6–7.[10]

Degenerative changes were significantly correlated with age, and diabetes was significantly associated with degenerative changes ($\chi^2 = 26.889$, $p < 0.001$), whereas hypertension ($p = 0.410$) and smoking ($p = 0.928$) were not. Takatalo et al. reported a significantly higher prevalence of lumbar disc degeneration in men, with the two lowest levels (L4–5 and L5–S1) accounting for 85% of degenerated discs.[9] In the present study, degenerative changes were not significantly associated with the cervical ($p = 0.965$), thoracic ($p = 0.973$) or lumbar ($p = 0.495$) region. Osman et al., in 40 patients, found disc degeneration in 42%, with dehydration most common at L4–5 and L5–S1.[11]

The study has limitations. It was a single-centre, cross-sectional study using convenient sampling, so causal relationships between age, comorbidities and vertebral pathology cannot be established and the findings may not be generalizable. Only patients aged 30–70 years with back pain were studied, and some subgroups, particularly cervical spondylosis ($n = 9$), were small. Larger, multicentre studies with a wider age range would help to confirm these findings.

Furthermore, psychological and psychosocial factors, such as anxiety, depression, emotional distress, pain catastrophizing and fear avoidance were not evaluated. The study was therefore unable to determine if psychological factors were linked to MRI identified abnormalities of the vertebrae or a factor in patients' pain and functional ability.

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ISSN: 3080-3489 (Print)
ISSN: 3080-3497 (Online)
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Future Research / Recommendation

Future studies should combine MRI results with age-related vertebral degeneration, comorbidities and pain-related clinical outcomes with psychological parameters (such as anxiety, depression, emotional distress and functional disability). The addition of validated instruments like PHQ-9, GAD-7, and ODI may contribute to a more comprehensive biopsychosocial understanding of vertebral pathologies, pain experience, psychological well-being and quality of life. Interdisciplinary studies can foster interdisciplinary cooperation between radiology, medical imaging, rehabilitation, clinical and health psychology, and promote comprehensive patient evaluation and management. [12–16]

Conclusion

This study demonstrates that there are important relationships between age, comorbidities, and vertebral MRI findings, particularly for the occurrence of lumbar spondylosis and degenerative changes. The results highlight the need to combine radiological and clinical evaluation and consider the possible impact of psychological and psychosocial factors on pain, functional ability and QOL. Future studies need to have a biopsychosocial approach, using validated psychological assessments in conjunction with MRI results.

Funding Statement

The authors received no specific funding for this research

Conflict of Interest:

The authors declare that they have no conficts of interest.

Acknowledgements

The authors have no acknowledgements to declare.

Transparency Statement

The authors confirm that this manuscript provides an honest, accurate, and transparent report of the study. No important aspects of the study have been omitted and any differences from the original study plan have been explained.

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