

ASSOCIATION OF LIFESTYLE FACTORS WITH LUMBAR DISC DEGENERATION AND HERNIATION IN YOUNG ADULTS USING MAGNETIC RESONANCE IMAGING

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Abstract

Background: Lumbar disc degeneration/herniation is one of the major causes of low back pain and functional limitation, and such abnormalities can be present even in young adults. Magnetic Resonance Imaging (MRI) offers a detailed, radiation-free view of the intervertebral discs, herniation, canal narrowing and nerve compression.

Objective: To assess the association of lifestyle factors with lumbar disc degeneration and herniation in young adults using MRI, and to describe the distribution of selected lumbar MRI findings.

Methods: A quantitative, cross-sectional analytical study was conducted among 73 young adults aged 20–40 years recruited by non-probability convenience sampling from hospital-based radiology settings in Lahore and Bahawalpur. Participants were categorized into desktop working, labour, prolonged standing, and sedentary lifestyle groups. MRI findings included disc levels affected, single/multiple involvement, T1- and T2-weighted disc signal, herniation location, dominant vertebral level, canal stenosis, stenosis level, and nerve compression. Data were analyzed in SPSS v23 using descriptive statistics and Pearson's Chi-square test ($p < 0.05$ considered significant).

Results: The mean age was 30.97 ± 5.18 years; 54.8% were female. Single-level disc involvement was observed in 71.2% of participants and multiple-level involvement in 28.8%. L4 was the dominant vertebral level in 46.6% and L5 in 32.9%. T2 hypointense disc signal was observed in 68.5%, canal stenosis in 69.9%, and nerve compression in 49.3%. Central herniation was the most frequent location (28.8%). No statistically significant association was found between lifestyle category and disc levels affected ($p = 0.165$), herniation location ($p = 0.492$), dominant vertebral level ($p = 0.639$), canal stenosis ($p = 0.222$), stenosis level ($p = 0.746$), or nerve compression ($p = 0.172$).

Conclusion: Lumbar MRI abnormalities are common among young adults, particularly at the lower lumbar levels, but the broad lifestyle categories assessed in this study were not significantly associated with the selected MRI

findings. Larger studies using detailed measures of occupational exposure, physical activity, sitting time, ergonomics, BMI, and clinical symptoms are recommended.

1. Introduction

Lumbar intervertebral disc degeneration (LDD) and lumbar disc herniation (LDH) are two prevalent musculoskeletal conditions that are associated with low back pain, radiculopathy, disability and loss of quality of life. The degenerative changes in the lumbar spine are considered age-related diseases but recent studies have demonstrated that these changes are becoming more common in young adults. People aged 18-40 years may be more susceptible due to lifestyle change, excessive sitting time, work-related stress, lack of physical activity and inadequate work posture practices [1,2]. The prevalence of lumbar disc disease in younger cohorts has key clinical and societal relevance, since symptoms can have negative impacts on education, work, mobility, and future productivity.

The biochemistry and structural changes of the intervertebral disc which lead to its degeneration are a multifactorial process. Usually, degeneration starts with the loss of proteoglycans and a decrease in water binding capacity in the nucleus pulposus, leading to dehydration of the disc, loss of elasticity, and the inability to distribute mechanical load. Structural damage can also progress to involve annulus fibrosus and vertebral endplates, ultimately leading to disc bulging, protrusion or herniation [14,15]. Lumbar disc herniation is where disc material protrudes from the confines of the intervertebral disc, and can compress adjacent nerve structures. Patients might have low back pain, radiation pain down the leg, numbness, weakness, or neurological deficits depending on the location and severity of the lesion [25].

Lumbar spine is subjected to high mechanical stresses during walking, standing, lifting, bending and rotational exercises. As a result, the most common areas of involvement are lower lumbar (L4-L5) and L5-S1. Pathology occurs at these levels is common with chronic low back pain, radiculopathy and functional restrictions [16]. Occupational exposure is an important

contributor to these disorders. Compressive and shear forces are increased over the lumbar discs when lifting, bending, twisting, standing in the same position for long periods of time, and working physically intensive jobs are repeated. However, inappropriate ergonomic support, such as in those who work at a desk or work long hours with a computer may affect the spinal loading as well [3,4,18].

In the younger adult, lifestyle-related factors have become a significant factor in the development of lumbar disc pathology. The reduction of spinal conditioning, as well as abnormal biomechanical loading, are factors that could be associated with sedentary behavior, excessive screen time, prolonged computer work and lack of physical activity [17]. Inactivity may lead to a weakening of the paraspinal and core muscles, thereby decreasing the stability of the spine and increasing the likelihood of lumbar problems. The opposite, however, is true for physical activity: regular, the right kind of physical activity may help to improve the biomechanics of the spine and minimize disability risks [23]. While participation in sports can have positive impacts, it can also have negative impacts, such as moderate activity promoting musculoskeletal health and high intensity activity with repetitive axial loading, flexion, extension or rotation involving disc injury in susceptible individuals [24].

Another risk factor that may be modifiable is body mass index (BMI). With weight gain, the axial load on the lumbar spine increases and this can lead to mechanical stress and inflammation in the disc that lead to disc breakdown. Thus, a relationship between lumbar disc pathology and overweight or obesity have been reported in studies [19]. Smoking is also thought to be an important risk factor as smoking-induced vasoconstriction can cause a decrease of blood supply to the vertebral endplates and disrupt the nutrient delivery to the relatively avascular intervertebral disc. This can increase disc dehydration, cell damage and break

down of extracellular matrix [20]. Genetic susceptibility can play a role in the progression and development of disc degeneration, as well as environmental and lifestyle factors. Even younger people may be more susceptible due to genetic differences in the activity of collagen formation, metabolism of extracellular matrix, and inflammatory pathways [21].

Psychological needs and stressors may also impact on how long symptoms last and how they are experienced in the lumbar region. Anxiety, depression and work-related stress increase pain perception, reduce physical activity and are negatively affecting functional recovery [22]. Therefore, it is important to take a holistic approach to the concept of lumbar disc degeneration and herniation and realize that it is not always a by-product of aging, but rather, a result of a combination of mechanical, occupational, metabolic, behavioral, genetic and psychosocial factors.

Lumbar disc disorders are a significant problem worldwide. Low back pain is widespread and in some studies lifetime prevalence is as high as 84% of the population [5,6]. The prevalence of lumbar disc pathology is reported to be from around 1.4% to 20% in different populations and the prevalence generally increases with age [7,8]. More importantly, the increasing awareness of a degenerative process in young adults emphasizes the need to study modifiable risk factors in young people before irreversible structural and functional damage occurs. The social and economic impacts are also significant, such as absenteeism, loss of productivity, health-care costs, restriction of activities and decreased quality of life [26].

Imaging is a key part of the evaluation for any disorders of the lumbar discs. In some clinical scenarios, plain radiography and computed tomography (CT) may be advantageous; however, they have some drawbacks for the assessment of soft tissue and intervertebral disc pathology. In younger patients, CT also exposes them to ionizing radiation [9–11] which is a factor to take into account. Excellent soft-tissue contrast and no ionizing radiation make magnetic resonance

imaging (MRI) the preferred imaging modality for lumbar disc pathology. MRI can visualize intervertebral disc, vertebral body, spinal canal, nerve roots, ligaments, facet joints and surrounding soft tissues in detail [12,13].

MRI is especially useful in the recognition of characteristic degenerative features such as disc dehydration, loss of disc height, abnormal annulus, Modic endplate changes, disc protrusion, and/or nerve root compression [27]. There are some standardised MRI grading systems to increase the uniformity of disc degeneration assessment. Of these, the Pfirrmann grading system is most common, as it assesses disc structure, signal intensity, separation of the nucleus from annulus, and height of the disc, and it is a reproducible way to categorize the severity of disc degeneration [28].

Although the prevalence of lumbar degenerative disc disease (LDDD) in young people is becoming more well known worldwide, specific data for the region is lacking in many developing nations. Young adults in Pakistan can be at risk of exposure to multiple factors such as physical demands of their jobs, prolonged sitting, inadequacy of awareness of ergonomic principles, sedentary lifestyle, use of computers and smart phones, and other risk factors that are potentially modifiable. Further studies to evaluate the correlation between these factors and MR proven lumbar disc degeneration and herniation can enhance understanding of this problem in the Pakistani population [29].

2. Materials and Methods

2.1 Research Design

This study used a quantitative, cross-sectional analytical research design to evaluate the association between lifestyle factors and lumbar disc degeneration and herniation in young adults using MRI. The analysis examined MRI findings across four lifestyle categories and described the distribution of lumbar disc abnormalities.

2.2 Clinical Settings

The study was conducted in hospital-based radiology settings in Lahore and Bahawalpur

where lumbar spine MRI examinations were available. Participants undergoing lumbar spine MRI and meeting the predefined selection criteria were recruited during the study period.

2.3 Sample Size

The sample size was 73 participants. The final dataset included 73 young adults within the study age range who met the predefined inclusion and exclusion criteria.

The sample size was calculated using the standard formula $n = (Z^2 \times p \times (1 - p)) / E^2$, where Z is the Z-score corresponding to the 95% confidence level (1.96), p is the expected prevalence (0.05), and E is the margin of error (0.05). This calculation yielded a minimum required sample size of approximately 73 participants.

2.4 Sampling Technique

A non-probability convenience sampling technique was used to recruit young adults aged 20–40 years who met the predefined inclusion and exclusion criteria and were available during the study period.

2.5 Selection Criteria

2.5.1 Inclusion Criteria:

- All individuals aged between 20 and 40 years.
- With history of lower back pain.
- Diagnosed with lumbar spine degeneration or herniation.
- Working at least for the last 2 years.
- Both genders.

2.5.2 Exclusion Criteria:

- Pregnant women.
- Individuals with a history of spinal surgery or lumbar spine interventions.
- Patients with known autoimmune diseases affecting the spine, such as ankylosing spondylitis.
- Individuals with traumatic spinal injuries or fractures.
- Patients with known malignancies involving the spine.

- Individuals with systemic infections (e.g., tuberculosis) affecting the lumbar spine.
- Patients with non-musculoskeletal causes of low back pain, such as kidney or gastrointestinal disorders.

2.6 Ethical Consideration

The study was conducted according to the ethical principles approved by the related institutional ethical committee. All participants had given written informed consent prior to their inclusion. The participants were informed about the confidentiality of the information they gave and how it would be utilized for research. There was no forced participation, and participants had the opportunity to drop out at any time without impacting on care.

2.7 Data Collection

After ethical approval, eligible participants were recruited according to the inclusion and exclusion criteria. Written informed consent was obtained. Demographic and lifestyle information was recorded on a pre-designed data collection sheet, while MRI findings were reviewed and recorded for disc levels affected, single or multiple involvement, T1- and T2-weighted disc signal, herniation location, dominant vertebral level, canal stenosis, stenosis level, and nerve compression.

2.8 Statistical Analysis

Data were analyzed using SPSS version 23. Age was summarized as mean $\pm$ standard deviation; categorical variables were presented as frequencies and percentages. Pearson's Chi-square test was used to assess associations between lifestyle category and categorical MRI findings, with $p < 0.05$ considered statistically significant.

3. Results

A total of 73 participants were included, with a mean age of 30.97 ± 5.18 years (range 20–40 years). Females comprised 54.8% (n=40) and males 45.2% (n=33) of the sample.

Table 1. Age Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	73	20	40	30.97	5.180
Valid N (listwise)	73				

The study included 73 participants, of whom 40 (54.8%) were female and 33 (45.2%) were male. Females therefore represented the larger proportion of the sample, exceeding males by 7 participants. The cumulative percentage reached

54.8% after females and 100.0% after males. Overall, the gender distribution was reasonably balanced, although females constituted a slight majority.

Table 2. Gender Distribution

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	40	54.8	54.8	54.8
Male	33	45.2	45.2	100.0
Total	73	100.0	100.0	

The bar chart illustrates the gender distribution of the 73 participants. Female participants formed the larger group with 40 cases (54.8%), compared with 33 male participants (45.2%). The difference

between the two groups was 7 participants, or 9.6 percentage points. The distribution shows a relatively balanced gender split with a modest predominance of females.

Table 3. Distribution of Lifestyle Categories

LifeStyle	Frequency	Percent	Valid Percent	Cumulative Percent
Desktop Working	17	23.3	23.3	23.3
Labour	18	24.7	24.7	47.9
Prolonged Standing	21	28.8	28.8	76.7
Sedentary	17	23.3	23.3	100.0
Total	73	100.0	100.0	

The bar chart presents the frequency of the four lifestyle categories included in the study. Prolonged standing was most frequent with 21 participants (28.8%), followed by labour with 18 (24.7%). Desktop working and sedentary lifestyles

each accounted for 17 participants (23.3%). The relatively similar bar heights indicate that all four lifestyle groups were adequately represented in the sample.

Table 4. Distribution of Key MRI Findings

MRI Finding	Category	n	%
Disc-level involvement	Single-level	52	71.2
	Multiple-level	21	28.8
Dominant vertebral level	L4	34	46.6
	L5	24	32.9
	L3 / S1 / L2	15	20.5
T2 disc signal	Hypointense	50	68.5
	Hyperintense	23	31.5
Herniation location	Central	21	28.8
	Foraminal	19	26.0
	Lateral recess	19	26.0
	Paracentral	14	19.2
Canal stenosis	Present	51	69.9
	Absent	22	30.1
Nerve compression	Present	36	49.3
	Absent	37	50.7

The two lowest levels (L4 and L5) had 79.5% of dominant-vertebra observations, consistent with the heavy focus of pathology at the lower lumbar levels. More than two thirds of participants had T2 hypointense signal, corresponding to a loss of disc hydration. Central herniation was the most common herniation pattern, but foraminal and

lateral-recess herniation was almost as common. Most subjects (69.9%) had canal stenosis and nearly half (49.3%) had nerve compression. As with the distribution of findings, the most common site for stenosis was L4-L5 (52.1%, n=38), followed by L3-L4 and L5-S1 (21.9% each, n=16), and L2-L3 (4.1%, n=3).

Table 5. Herniation Location by Lifestyle Category: Cross-Tabulation (n)

LifeStyle	Central	Foraminal	Lateral recess	Paracentral	Total
Desktop Working	7	3	7	0	17
Labour	4	5	4	5	18
Prolonged Standing	5	6	5	5	21
Sedentary	5	5	3	4	17
Total	21	19	19	14	73

The Pearson chi-square test examined the association between lifestyle and herniation location. The Pearson chi-square value was 8.421 with 9 degrees of freedom and a two-sided p-value of 0.492. The likelihood-ratio value was 11.386

with 9 degrees of freedom and $p=0.250$. Both p-values exceed 0.05, indicating no statistically significant association between lifestyle and herniation location in this dataset.

Table 6. Dominant Vertebral Level by Lifestyle Category: Cross-Tabulation (n)

LifeStyle	L2	L3	L4	L5	S1	Total
Desktop Working	1	3	5	8	0	17
Labour	0	1	8	7	2	18
Prolonged Standing	1	2	12	4	2	21
Sedentary	0	1	9	5	2	17
Total	2	7	34	24	6	73

The Pearson chi-square test evaluated whether the distribution of dominant vertebral levels differed by lifestyle. The Pearson chi-square statistic was 9.735 with 12 degrees of freedom and a two-sided p-value of 0.639. The likelihood-ratio statistic was

11.904 with 12 degrees of freedom and $p=0.453$. These results do not indicate a statistically significant association between lifestyle category and dominant vertebral level at the 0.05 significance level.

Table 7. Canal Stenosis by Lifestyle Category: Cross-Tabulation (n)

LifeStyle	No	Yes	Total
Desktop Working	2	15	17
Labour	7	11	18
Prolonged Standing	6	15	21
Sedentary	7	10	17
Total	22	51	73

The Pearson chi-square test assessed whether canal stenosis status was associated with lifestyle category. The Pearson chi-square statistic was 4.389 with 3 degrees of freedom and a two-sided p-value of 0.222. The likelihood-ratio statistic was

4.821 with 3 degrees of freedom and $p=0.185$. Both tests yielded p-values above 0.05, so the observed differences in stenosis frequencies were not statistically significant.

Table 8. Stenosis Level by Lifestyle Category: Cross-Tabulation (n)

LifeStyle	L2-L3	L3-L4	L4-L5	L5-S1	Total
Desktop Working	1	3	10	3	17

LifeStyle	L2-L3	L3-L4	L4-L5	L5-S1	Total
Labour	0	3	9	6	18
Prolonged Standing	2	5	11	3	21
Sedentary	0	5	8	4	17
Total	3	16	38	16	73

The Pearson chi-square test evaluated whether stenosis level differed significantly between lifestyle groups. The Pearson chi-square statistic was 5.940 with 9 degrees of freedom and a two-sided p-value of 0.746. The likelihood-ratio

statistic was 6.877 with 9 degrees of freedom and $p=0.650$. Both results are well above 0.05, indicating no statistically significant association between lifestyle and stenosis level.

Table 9. Nerve Compression by Lifestyle Category: Cross-Tabulation (n)

LifeStyle	No	Yes	Total
Desktop Working	6	11	17
Labour	10	8	18
Prolonged Standing	9	12	21
Sedentary	12	5	17
Total	37	36	73

The Pearson chi-square test examined the association between lifestyle category and nerve compression. The Pearson chi-square statistic was 4.991 with 3 degrees of freedom and a two-sided p-value of 0.172. The likelihood-ratio

statistic was 5.101 with 3 degrees of freedom and $p=0.165$. Neither test reached statistical significance at $p<0.05$, so the observed variation in nerve compression across lifestyle groups was not statistically significant.

Table 10. Pearson's Chi-Square Test for Association Between Lifestyle Category and MRI Findings

MRI Finding	χ^2	df	p-value
Disc levels affected	27.180	21	0.165
Herniation location	8.421	9	0.492
Dominant vertebral level	9.735	12	0.639
Canal stenosis	4.389	3	0.222
Stenosis level	5.940	9	0.746
Nerve compression	4.991	3	0.172

None of the associations between lifestyle category and the MRI outcomes examined reached statistical significance (all $p > 0.05$), indicating that the broad lifestyle categories used in this study were not significantly related to the pattern of lumbar disc degeneration, herniation, stenosis, or nerve compression observed on MRI.

4. Discussion

The present study investigated the relationship between lifestyle factors and lumbar disc degeneration and herniation in 73 young adults, using MRI. The high prevalence of lumbar MRI abnormalities, including multilevel involvement (28.8%), is consistent with recent literature demonstrating a high burden of lumbar MRI abnormalities in a young population with low back pain [17] and, in that study, 58.2% of 146 young adults (18–35 years) had disc degeneration, while 30.8% had multilevel involvement. In both studies, there was a clear predominance in the lower lumbar levels, which is consistent with the greater mobility and mechanical loading of the lower lumbar levels, L4–L5 and L5–S1.

A decreased T2 signal, seen in 68.5% of this group, is a known sign of degeneration, which is associated with loss of hydration of the disc. A widely quoted systematic review and meta-analysis of imaging data in asymptomatic people found that with age, the percentage of people with degenerative MRI characteristics, such as disc degeneration and disc bulge, rose steadily and were common in people who were not experiencing symptoms [18]. The relatively high rates of T2 hypointensity and canal stenosis seen in this young subset of patients should be interpreted with caution and should always be correlated with clinical presentation, as imaging abnormalities do not parallel symptomatic disease [18].

Importantly, none of the lifestyle associations studied in this paper were statistically significant. This finding is in contrast to some occupational studies but in line with others. This could in part be because the genetic component to lumbar disc degeneration and its progression over time is

significant and in some analyses dominant, as found in twin and family studies [19,20]. Likewise, a longitudinal population-based MRI study has shown that reduced physical activity was associated with increased disc degeneration over 14 years but that no significant association was found between physical exposure and occupational labour, walking or cycling, per se [21], highlighting that how physical exposure is defined and measured greatly affects the detection of an association.

Occupational-loading studies have also yielded conflicting results, with some showing a relationship between specific job tasks and disc bulge pattern, while other studies, including an analysis by administrative and physically active occupational groups, indicate a lack of consistency between the type of occupation and disc degeneration among non-heavy workers. Other more recent studies investigating severe lumbar disc degeneration and self-reported heavy occupational loading have found significant associations at the L5–S1 level, but mainly in older or postmenopausal individuals [23], a population that significantly differs from the young mixed-sex population analyzed in this study. These discrepancies collectively indicate that these broad occupational classes may not be sensitive enough to the cumulative mechanical exposure, duration, posture, and ergonomic variations that could be responsible for disc pathology, and that differences in individual exposures within any single lifestyle class (e.g., lifting postures, sitting postures) may obscure any true association [12,21–22].

4.1 Limitations

The cross-sectional design did not allow for assessment of disease progression or for causal inference. Lifestyle exposure was only measured in terms of occupational categories and not specifically in relation to sitting/standing time, lifting frequency, posture or ergonomic factors. Clinical symptoms, neurological status, functional disability or other risk factors such as BMI, smoking, or previous spinal injury were not correlated with MRI findings. Additionally, the

sample size was relatively small (n=73) and may result in limited power to detect true associations.

5. Conclusion

MRI abnormalities in the lumbar spine are common in young adults, with most occurring at the lower levels of the spine (L4 and L5) and involving disc-signal alteration, herniation, canal stenosis and nerve compression. Overall, the various broad categories of lifestyle assessed in this study (desktop working, labour, prolonged standing and sedentary lifestyle) did not show significant correlation with these MRI measures. MRI is a useful, radiation-free diagnostic tool for detecting early structural change in the lumbar spine of healthy young adults, but larger studies with well-defined and characterized lifestyle factors should be conducted to elucidate the association between lifestyle and lumbar disc disease.

6. Recommendations

Further study is warranted, including: (1) larger, multicenter studies to enhance generalizability; (2) longitudinal studies to better understand the progression of degeneration with sustained lifestyle and/or occupational exposures; (3) detailed quantitative analysis of sitting/standing duration, occupational workload, lifting activity, sitting/standing posture and ergonomic exposure; and (4) systematic correlation of MRI findings with clinical symptoms, neurological status, functional disability, BMI, and other relevant risk factors.

Author Contributions

T.B. supervised the study, contributed to the conceptual design, and critically revised the manuscript. S.M.I. participated in the design of the study, data collection, MR data review, analysis and manuscript drafting. M.K., M.A.S., and Z.G. participated in data collection, data interpretation, and revision of the manuscript. All the authors read and approved the final manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest.

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References

1. Adams MA, Roughley PJ. What is intervertebral disc degeneration, and what causes it? *Spine*. 2006;31(18):2151-2161.
2. Samartzis D, Karppinen J, Mok F, Fong DYT, Luk KDK, Cheung KMC. A population-based study of juvenile disc degeneration and its association with overweight and obesity, low back pain, and exercise. *Spine*. 2011;36(25):E1650-E1656.
3. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. 2012;64(6):2028-2037.
4. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. *Lancet*. 2018;391(10137):2356-2367.
5. Chou R, Qaseem A, Snow V, Casey D, Cross JT, Shekelle P, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline. *Ann Intern Med*. 2007;147(7):478-491.
6. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N. Magnetic resonance classification of lumbar intervertebral disc degeneration. *Spine*. 2001;26(17):1873-1878.
7. Fardon DF, Williams AL, Dohring EJ, Murtagh FR, Rothman SLG, Sze GK. Lumbar disc nomenclature: version 2.0. *Spine J*. 2014;14(11):2525-2545.
8. Urban JPG, Roberts S. Degeneration of the intervertebral disc. *Arthritis Res Ther*. 2003;5(3):120-130.

9. Raj PP. Intervertebral disc: anatomy-physiology-pathophysiology-treatment. *Pain Pract.* 2008;8(1):18-44.
10. Zhang YG, Guo TM, Guo X, Wu SX. Clinical diagnosis for discogenic low back pain. *Int J Biol Sci.* 2009;5(7):647-658.
11. Teraguchi M, Yoshimura N, Hashizume H, Muraki S, Yamada H, Minamide A, et al. Prevalence and distribution of intervertebral disc degeneration over the entire spine in a population-based cohort. *Spine.* 2014;39(6):E392-E399.
12. Luoma K, Riihimäki H, Raininko R, Luukkonen R, Lamminen A, Viikari-Juntura E. Lumbar disc degeneration in relation to occupation. *Scand J Work Environ Health.* 1998;24(5):358-366.
13. Samartzis D, Karppinen J, Chan D, Luk KDK, Cheung KMC. The association of lumbar intervertebral disc degeneration on MRI with body mass index, age, and low back pain. *Spine.* 2011;36(10):811-817.
14. Williams FMK, Sambrook PN. Neck and back pain and intervertebral disc degeneration: role of occupational and lifestyle factors. *Best Pract Res Clin Rheumatol.* 2011;25(1):69-79.
15. Battié MC, Videman T, Kaprio J, Gibbons LE, Gill K, Manninen H, et al. Genetic influences on cervical and lumbar disc degeneration. *Arthritis Rheum.* 2002;46(10):2699-2705.
16. Steffens D, Hancock MJ, Maher CG, Williams C, Jensen TS, Latimer J. Does magnetic resonance imaging predict future low back pain? A systematic review. *Eur J Pain.* 2014;18(6):755-765.
17. Saleem R, Khan S, Slehria AUR, Aquil H, Halim A. Pattern of lumbar disc degeneration in young adults with low back pain on 3.0 Tesla magnetic resonance imaging. *J Pak Med Assoc.* 2025;75(4):587-591.
18. Brinjikji W, Luetmer PH, Comstock B, Bresnahan BW, Chen LE, Deyo RA, et al. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. *AJNR Am J Neuroradiol.* 2015;36(4):811-816.
19. Livshits G, Popham M, Malkin I, MacGregor AJ, Swanberg M, Yip A, et al. Lumbar disc degeneration and genetic factors: a study of progression over a decade. *Ann Rheum Dis.* 2011;70(7):1203-1207.
20. Battié MC, Videman T, Gibbons LE, Fisher LD, Manninen H, Gill K. Determinants of lumbar disc degeneration: a study relating lifetime exposures and magnetic resonance imaging findings in identical twins. *Spine.* 1995;20(24):2601-2612.
21. Maurer E, Klinger C, Lorbeer R, Rathmann W, Peters A, Schlett CL, et al. Long-term effect of physical inactivity on thoracic and lumbar disc degeneration—an MRI-based analysis of 385 individuals from the general population. *Spine J.* 2020;20(9):1386-1396.
22. Battié MC, Videman T, Levalahti E, Gill K, Kaprio J. Genetic and environmental effects on disc degeneration by phenotype and spinal level: a multivariate twin study. *Spine.* 2008;33(25):2801-2808.
23. Salo S, Hurri H, Riihonen T, Sund R, Kröger H, Sirola J. Association between severe lumbar disc degeneration and self-reported occupational physical loading. *J Occup Health.* 2022;64(1):e12316.