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Prevalence and Assossiated Risk Factors of Disc Bulging in Lumbosacral Spine using Magnetic Resonance Imaging

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ABSTRACT

Lumbosacral disc bulging is a common spinal disorder affecting quality of life, making its prevalence and risk factors important for early management. This descriptive cross-sectional study at the Radiology Department, Khyber Teaching Hospital, Peshawar, included 289 patients (18–65 years). Data from interviews, questionnaires, and MRI were analyzed using SPSS 24. Disc bulging prevalence was 97.9% (n = 283), mostly in females (60.9%) and ages 36–45 years (30.8%). Housewives were the largest group (44.6%). BMI: 54.0% normal, 42.6% overweight. 88.9% reported lower back pain, with 50.5% chronic for years; 47.4% had moderate pain, mainly on standing (29.1%) and walking (27.7%). Risk factors: smoking (22.5%), hypertension (65.4%), diabetes (42.2%), osteoporosis (18.7%). MRI: L4–L5 (33.2%), L5–S1 (27.0%), L4–S1

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(17.3%), L3–L4 (10.4%). Chi-square showed significant association with occupation ($p = 0.017$), but not with age ($p = 0.194$), gender ($p = 0.580$), or BMI ($p = 0.123$, near-significant linear trend $p = 0.049$). Findings highlight high prevalence, particularly at lower lumbar levels, influenced by occupation, obesity, and comorbidities. Early MRI, lifestyle modification, and ergonomic care are recommended.

Keywords: Disc bulging, Lumbosacral spine, MRI, Lower back pain, Risk factors, Occupation, BMI, Hypertension, Diabetes, Osteoporosis, Prevalence

INTRODUCTION

The lumbosacral spine, encompassing lumbar vertebrae L1 through L5 and the sacrum (S1), forms the structural foundation for axial load-bearing, multiplanar mobility, and protection of the cauda equina and exiting nerve roots. Each lumbar vertebra features a robust vertebral body designed to manage compressive loads, along with posterior neural arches that house spinal cord structures. Intervertebral discs consisting of a central nucleus pulposus and an outer annulus fibrosus serve as key shock absorbers. The nucleus pulposus, rich in proteoglycans and water, distributes compressive forces evenly, while the annulus fibrosus, composed of concentric collagen lamellae, resists radial expansion and enables flexibility in flexion, extension, rotation, and lateral bending (Nordberg *et al.*, 2021; Urban & Roberts, 2003; Adams & Roughley, 2006).

Lower lumbar motion segments, especially L4–L5 and L5–S1, experience heightened biomechanical stress due to their horizontal facet orientation and their role in bearing a larger share of body weight. Such stress subjects these segments to shear, compression, and torsional forces. Over time, these mechanical demands lead to microtrauma and progressive

Lumbar spine anatomy with intervertebral discs and nerve roots. degeneration: loss of proteoglycans and hydration in the nucleus pulposus increases intradiscal pressure, weakening the annulus fibrosus and promoting outward bulging across more than 25% of the disc circumference (Nordberg *et al.*, 2021; Wang *et al.*, 2016a).

Disc bulging refers to the uniform extension of disc material beyond the vertebral margins without annular rupture. It is considered an early stage of disc degeneration,

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precipitated by biochemical changes such as proteoglycan depletion, collagen fiber disorganization, and loss of hydration and mechanical stresses like repetitive loading and microtrauma (Adams & Roughley, 2006; Urban & Roberts, 2003; Segar *et al.*, 2024). Risk factors include advancing age, obesity, smoking, sedentary lifestyle, occupational strain, and genetic disposition (Battie *et al.*, 2004).

While often asymptomatic, disc bulges can provoke low back pain, radiculopathy, or neurogenic claudication if they compress nerve structures (Nordberg et al., 2021; Brinjikji *et al.*, 2015). Studies indicate that disc bulge prevalence increases from roughly 30% in individuals aged 20 to approximately 84% by age 80, surpassing focal protrusion

(Brinjikji *et al.*, 2015). Normal lumbar intervertebral disc versus bulging disc causing nerve root compressionCT and MRI epidemiological studies consistently demonstrate near universal age related disc degeneration. In a systematic review involving 3,110 asymptomatic individuals, disc degeneration was present in 37% of 20 year olds and in 96% of 80 year olds. Disc bulging rose from 30% to 84% across the same age spectrum. The L4–L5 and L5–S1 levels were disproportionately affected due to their central role in load transmission (Brinjikji *et al.*, 2015; Kjaer *et al.*, 2005; Segar *et al.*, 2024).

MRI is the diagnostic standard for lumbosacral pathology thanks to its high resolution soft tissue contrast and lack of ionizing radiation. T2-weighted sequences are essential for assessing disc hydration healthy discs show high signal intensity, while degenerated or bulging discs exhibit decreased or heterogeneous signals (Segar *et al.*, 2024; Wang *et al.*, 2016b). Sagittal imaging evaluates disc height, alignment, bulge extent, and lumbar lordosis, whereas axial imaging is vital for assessing neural foraminal and canal compromise. Advanced techniques, such as weight bearing or axial loaded MRI, more accurately replicate physiological spinal loading and improve detection of dynamic nerve root compression (Heba & Diab, 2021). Lumbosacral MRI showing sagittal T2-weighted, axial T2-weighted, weight-bearing, and axial loaded sequences used for evaluating spinal pathology Disc bulging develops from a complex interplay of non modifiable and modifiable factors such as age, genetics, biomechanical load, lifestyle, and systemic health. Obesity,

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quantified by body mass index (BMI), is a leading modifiable factor with significant impact (Samartzis *et al.*, 2013).

Age is the primary risk factor with advancing age comes loss of proteoglycans, reduced disc hydration, and annular weakening (Nordberg *et al.*, 2021; Wang et al., 2016a). Genetic factors also influence disc structure, inflammation response, and degeneration rates (Battie *et al.*, 2004). Occupational physical demands such as manual labor, repetitive bending, heavy lifting, and whole body vibration increase risk considerably; lumbar disc herniation (LDH) with radiculopathy shows odds ratios of 1.6–3.7 in these professions (Segar *et al.*, 2024).Obesity imposes both mechanical loading and systemic inflammatory stress on the spine:In a study of 1,634 patients using MRI, each 5 kg/m² increase in BMI correlated with a 0.04 unit rise in disc degeneration (on a 5 point scale), an odds ratio (OR) of 1.19 for disc herniation, and an OR of 2.60 for spinal stenosis (Segar et al., 2024).

Biomechanical modeling at L3–L4 demonstrated that obesity increases range of motion and intradiscal pressure across all planes flexion (3.44% increase), extension (22.7%), lateral bending (29.7%), and axial rotation (33.2%) (MDPI, 2024).higher rates of surgical complications (Samartzis *et al.*, 2013). Recurrence of LDH post discectomy affects 7.4% of patients with BMI >24.4 kg/m² (Fotakopoulos *et al.*, 2018). Comorbid conditions like diabetes and hypertension further exacerbate complications and delay recovery (PMCID, 2012).

Given the strong link between obesity and disc pathology, primary prevention should prioritize weight management through diet and exercise (Samartzis *et al.*, 2013). Ergonomic improvements including proper lifting techniques, optimal seating, and core strengthening programs can reduce intradiscal pressure. Emerging technologies like weight bearing MRI offer enhanced diagnostic accuracy in symptomatic cases (Heba & Diab, 2021). Additionally, metabolic control and smoking cessation serve to slow degeneration and improve outcomes (Wang et al., 2016b; Samartzis *et al.*, 2011).

Lumbosacral disc bulging is a prevalent, multifactorial disorder driven by age, genetics, mechanical burden, metabolic health, and lifestyle behaviors. Although often asymptomatic particularly in older adults it has the potential to evolve into

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symptomatic herniation, stenosis, or chronic low back pain. Obesity, as measured by BMI and visceral fat accumulation, is a modifiable factor with significant impact on both mechanical loading and systemic inflammation. Early MRI detection and lifestyle interventions, especially weight reduction and ergonomic strategies, are critical steps in prevention and management. Well, designed longitudinal studies are needed to elucidate causal pathways and fine-tune intervention thresholds (Brinjikji *et al.*, 2015; Wang, 2016).

Methodology

This research employed a **cross-sectional study design** to investigate the prevalence of disc bulging. The study was conducted at the Department of Radiology within **Khyber Teaching Hospital (KTH), Peshawar**, spanning a four-month duration from **May to August 2025**. To gather the necessary data, a **non-probability convenience sampling technique** was utilized for participant recruitment.

The required sample size was determined using the following statistical formula:

$$n = \frac{Z^2 P(1-P)}{e^2}$$

Given a **95% confidence level** ($Z = 1.96$), an expected **prevalence (P) of 25%**, and a **5% margin of error (e)**, the calculation was performed as follows:

$$n = \frac{(1.96)^2 \times 0.25 \times (1-0.25)}{(0.05)^2}$$

This resulted in a calculated sample size of **289 participants**.

Specific selection criteria were established to ensure the integrity of the study group. The inclusion criteria targeted participants aged 18–65 years who were referred for an MRI of the lumbosacral spine, whether they presented with or without low back pain (LBP). Conversely, the exclusion criteria filtered out individuals outside the 18–65 age range to maintain group homogeneity. Additionally, pregnant women were excluded due to potential fetal risks and MRI safety concerns. Patients seeking post-operative follow-up, as well as individuals with contraindications such as severe claustrophobia or metallic implants, were also excluded.

The data collection procedure commenced following formal approval from the

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research committee of the Sarhad Institute of Allied Health Sciences (SIAHS) at Sarhad University, Peshawar. Data was acquired through a combination of patient interviews, clinical examinations, and radiological investigations (MRI) to confirm the presence of disc bulging. Furthermore, the DASH questionnaire was utilized as a primary tool for data gathering. Throughout the process, strict measures were implemented to ensure participant confidentiality. Finally, the data analysis procedure was carried out using SPSS version 24 to process and interpret the findings.

RESULTS

Table 4.1 presents the demographic characteristics of 289 participants, including 113 males (39.1%) and 176 females (60.9%). The majority were aged 36–45 years (30.8%, n = 89). Housewives formed the largest occupational group (44.6%, n = 129). Regarding BMI, most had normal weight (54.0%, n = 156), followed by overweight individuals (42.6%, n = 123).

Table 4.1: Demographic Characteristics of the Participants:

S No.	Variable	Category	Frequency (n)	Percent (%)
1.	**Age**	18–25	24	8.3
		26–35	57	19.7
		36–45	89	30.8
		46–55	76	26.3
		56–65	43	14.9
		Total	289	100.0
2.	**Gender**	Male	113	39.1
		Female	176	60.9
		Total	289	100.0
3.	**Occupation**	Housewife	129	44.6
		Black-collar job	33	11.4
		White-collar job	31	10.7

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		Teacher	32	11.1
		Athlete	1	0.3
		Student	24	8.3
		Others	39	13.5
		Total	289	100.0
4.	**BMI**	Overweight	123	42.6
		Normal	156	54.0
		Underweight	10	3.5
		Total	289	100.0

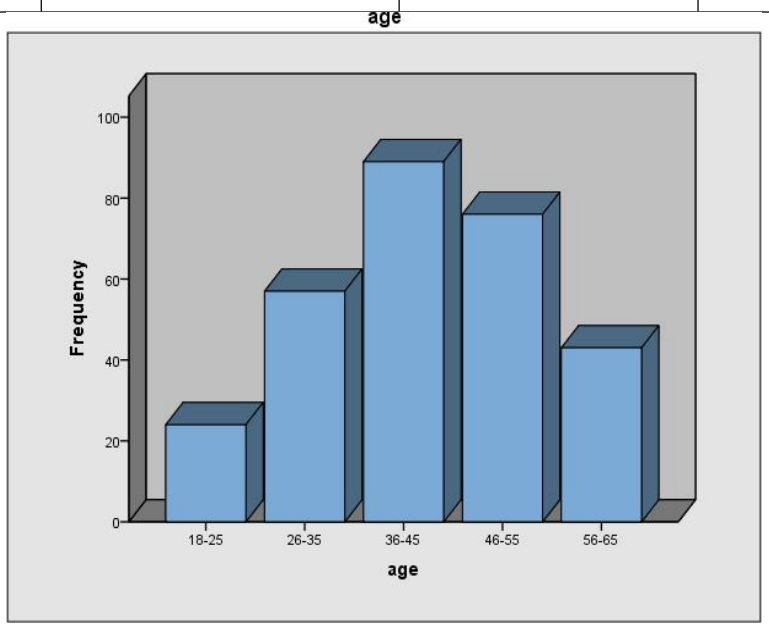


Figure 4.2 Frequency distribution of BMI in Participants

Table 4.2 shows that Most people in the study (88.9%, n = 257) had lower back pain, and about half of them had been dealing with it for years (50.5%, n = 146). Moderate pain was the most common (47.4%, n = 137), and pain was mostly felt while standing (29.1%, n = 84) or walking (27.7%, n = 80).

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Table 4.2 Clinical characteristics of participants with lower back pain (N = 289):

S No.	Variable	Category	Frequency (n)	Percent (%)
1.	**Current Lower Back Pain**	Yes	257	88.9
		No	32	11.1
		Total	**289**	**100.0**
2.	**Duration of Pain**	Weeks	39	13.5
		Months	104	36.0
		Years	146	50.5
		Total	**289**	**100.0**
3.	**Pain Intensity**	Mild	39	13.5
		Moderate	137	47.4
		Severe	113	39.1
		Total	**289**	**100.0**
4.	**Position of Pain Occurrence**	While sitting	49	17.0
		While standing	84	29.1
		While walking	80	27.7
		While bending/lifting	63	21.8
		While lying down	8	2.8
		Others	5	1.7
		Total	**289**	**100.0**

Table 4.3 shows that out of 289 participants, 66 (22.8%) reported that they smoke, while 223 (77.2%) said they do not.

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Table 4.3 Smoking status of participants (N = 289):

Category	Frequency (n)	Percent (%)
Yes	66	22.8
No	223	77.2
Total	**289**	**100.0**

In table 4.4 among the participants, 42.2% (n = 122) had diabetes, 65.4% (n = 189) had hypertension, and 18.7% (n = 54) were diagnosed with osteoporosis.

Table 4.4 Health status of participants (N = 289):

S No.	Variable	Category	Frequency (n)	Percent (%)
1.	**Diabetes**	Yes	122	42.2
		No	167	57.8
		Total	**289**	**100.0**
2.	**Hypertension**	Yes	189	65.4
		No	100	34.6
		Total	**289**	**100.0**
3.	**Osteoporosis (Weak Bones)**	Yes	54	18.7
		No	235	81.3
		Total	**289**	**100.0**

Disc bulging was present in most participants (97.9%, n = 283), while only 6 (2.1%) had no bulging. The most common sites were L4–L5 (33.2%, n = 96) and L5–S1 (27.0%, n = 78), followed by L4–S1 (17.3%, n = 50) and L3–L4 (10.4%, n = 30).

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Table 4.5 Presence and location of disc bulging among participants (N = 289):

S No.	Variable	Category	Frequency (n)	Percent (%)
1.	**Disc Bulging Present**	Yes	283	97.9
		No	6	2.1
		Total	**289**	**100.0**
2.	**Location of Disc Bulging**	L1–L2	6	2.1
		L2–L3	6	2.1
		L3–L4	30	10.4
		L4–L5	96	33.2
		L5–S1	78	27.0
		L3–S1	17	5.9
		L4–S1	50	17.3
		None	6	2.1
		Total	**289**	**100.0**

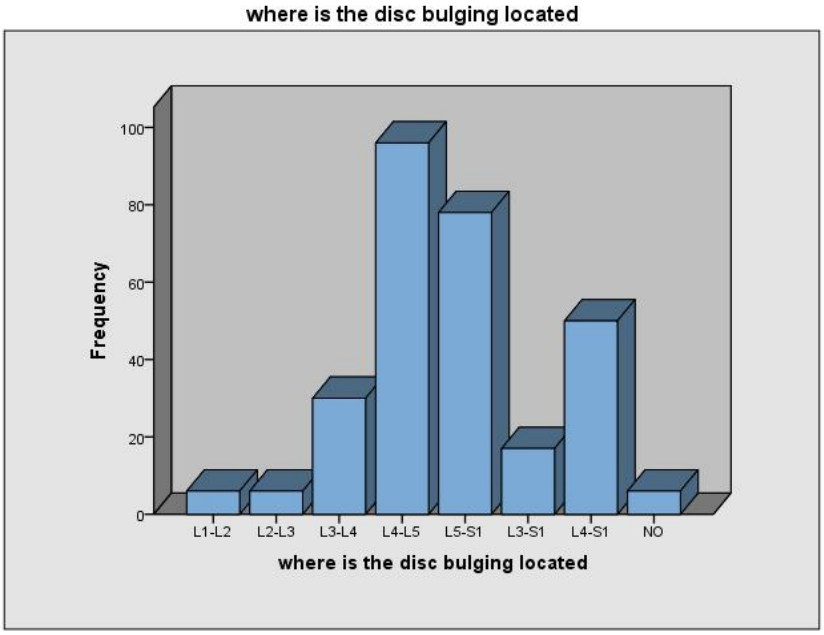


Figure 4.3 Frequency Distribution of Disc bilging among Participants

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The prevalence of lumbar disc bulging (LDB) was found to vary across different demographic and clinical categories. Age distribution showed that LDB was most frequently observed among individuals aged 36–45 years (30.4%), followed by those in the 46–55 year group (25.6%), although the association with age did not reach statistical significance ($p = 0.194$). Gender analysis revealed a higher prevalence in females (59.9%) compared to males (38.1%), but this difference was also statistically non-significant ($p = 0.580$). With respect to body mass index (BMI), disc bulging was more common in individuals with a normal BMI (53.6%) and those classified as overweight (40.8%), while obese individuals contributed less, though the relationship was not statistically significant ($p = 0.123$). Occupational category, however, showed a significant association with disc bulging ($p = 0.017$). The highest proportion of cases was noted among housewives (43.9%), followed by black-collar workers (11.4%) and white-collar workers (10.7%), suggesting that lifestyle and work-related physical activities may play a contributory role. In terms of comorbidities, the presence of osteoporosis (18.7%) did not show a significant correlation with LDB ($p = 0.235$). On the other hand, systemic conditions such as diabetes mellitus (42.2%; $p = 0.034$) and hypertension (65.1%; $p = 0.011$) demonstrated statistically significant associations with disc bulging, highlighting the potential influence of metabolic and vascular factors in the development of degenerative spinal changes.

Table 4.6 Association of demographic and clinical risk factors with disc bulging based on Chi-square test N = 289):

S No.	Variables		Frequency of the Disc Bulging N = 283	X2 (Chi-square value)	P (Probability value)
1.	Age of the Participants	18-25 years	22 (7.6%)	6.075	0.194
		26-35 years	56 (19.4%)		
		36-45 Years	88 (30.4%)		
		46-55 Years	74 (25.6%)		
		56-65 Years	43 (14.9%)		

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2.	Gender of the participants	Male	110(38.1%)	0.306	0.580
		Female	173 (59.9%)		
3.	BMI of the participants	Overweight	118 (40.8%)	4.186	0.123
		Normal	155 (53.6%)		
		Underweight	10(3.5%)		
4.	Occupation of the participants			15.381	0.017
		Housewife	127(43.9%)		
		Black collar job	33(11.4%)		
		White collar job	31(10.7%)		
		Teacher	31(10.7%)		
		Athlete	1(0.3%)		
		Student	21(7.3%)		
		Others	39(13.5%)		

DISCUSSION

Low back pain is among the leading causes of global disability, and disc bulging is commonly observed in patients who undergo MRI for this complaint. The current study tried to find the correlation of KP data with previous findings in both Pakistan and elsewhere in world.

In our cohort, majority of patients referred to MRI with low back pain had bulging (283/289 cases; 97.9%). This high proportion is anticipated in a hospital-based population; patients there are likely to have chronic or severe disease. In comparison, Community based studies conducted in Pakistan (among students, healthcare workers and teachers) have reported a prevalence of LBP about 30–45%. Similar results were reported also on an international level. In the Netherlands, 94% of patients with low back pain were observed to have abnormalities including herniation or bulging as well (de Schepper et al., 2016). The McGill study, concluded that 37.2% of the subjects age 20-22 and nearly four-fifths (79.4%) of

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those aged between 38–42 had at least one degenerated disc in their lumbosacral spine, only looking on a regional level (Battié et al., 2009).An extensive population based study conducted in Southern China documented more than 90% of healthy adults younger than age 50-55 presenting signs of MRI degeneration even without hospital referral (Cheung et al.,, Luoma et al.). This was also confirmed in a South Korean meta-analysis where bulging is, compared to symptom free people, occurring several times more with associated back pain (Brinjikji et al., 2015). Taken together, these data put in perspective our results and emphasize that the prevalence found here corresponds to a clinical sample and not a population base.

Age-related patterns were also observed. Patients in their 20s to 40s had very high rates of bulging, with 97.5% in their 20s and 98.9% in their 40s, most commonly at L4–L5. Bulging at L5–S1 or multiple levels was more frequent in older patients, indicating age-associated downward displacement of degeneration. More varied findings have been observed in non-clinical populations from prior studies. One review observed that bulging discs amongst patients without symptoms go from less than 30% at age 20 to over 84% by age 80 (Brinjikji et al.,2015). Another study also found that 85% of asymptomatic individuals older than 55 had at least one disc bulge (Tong et al., 2006), and another report postulated that by the time they are reaching age 40, as much as half of the already have a disc bulges already present (Davis et al.; 2024). In comparison with these estimates our very high reactivation rates in the present study might represent selection of symptomatic, hospital-based cases.

Amongst the gender proportion, women accounted for a larger number of cases (60.9% vs 39.1%). It could be associated with domestic commitments in Khyber Pakhtunkhwa, repetitive bending and lifting as well as prolonged standing which gives additional load on spine. Also in line with such finding, a comparative study among Pakistan reported females to have slightly more tendency for degeneration L4–L5 and L5–S1 segments compared to male Azeem et al. (2022). This indicate that both cultural and anatomical causes can be at the root of the gender bias.

This is supported by the pain profile in our sample, which alludes to mechanical load as a significant influence. Among the various types of movement, a larger proportion

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of patients reported being in pain while walking (about 29.1%), standing (28.7%) and bending/lifting weights (21.8%); smaller groups said they were only in pain mainly when sitting down (17.0%) or lying down (2.8%). These results are consistent with the concept that factors such as load-bearing posture and repetitive strain are key elements in discogenic pain.

Comorbidities were common in patients with bulging: obesity (42.6%), diabetes (42.2%), hypertension (65.4%) and osteoporosis 18.7%. Such conditions are quite common in Pakistan (Bhatti 2025; World Life Expectancy, 2025) and may further burden the vertebral column. In fact, some studies have even reported a relationship between osteoporosis and fewer disc changes (Miyakoshi et al., 2003), but being without osteoporosis, patients still bulged in our study highlighting other lifestyle and mechanic factors. The comorbidity of diabetes and hypertension in numerous patients may illustrate Pakistan's high burden of metabolic disorders, which is known to expedite a disc degenerative process (Rohlmann et al., 2006).

Occupational analysis also stressed the importance of daily posture. Among the affected population were the housewives, who accounted for 40.1% of all cases, followed by teachers (13.1%), white-collar workers (11.8%) and black-collar workers (7.6%). These are typically jobs or tasks in which the back is loaded by bending, standing for long periods, lifting etc. A research study from Islamabad reported that housewives were most affected 30% followed by office workers18%, laborer15%, and healthcare worker12% while almost half of the patients had reported heavy lifting, prolonged sitting or twisting as aggravating factors (Zafar & Qasim, 2018). This comparison confirms the uniformity in Pakistan.

Analysis of disc levels revealed that L4–L5 was most frequently affected (33.9%), followed by L5–S1 (27%) and multilevel, involving L4–S1 (17.3%). Upper lumbar bulges were rare. This is in accordance with international literature (Rohlmann et al., 2006) where it is mentioned that approximately 95% of the discal problems are located on levels L4–L5 and L5–S1 as these two segments carry the largest amount of loading and mobility. Our observation of younger adults more commonly afflicted at L4–L5 and the elderly at L5–S1 or multilevel similarly reflects the age-related downward fashion of disease based on worldwide studies.

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CONCLUSION

The findings demonstrated that disc bulging was exceedingly prevalent, with L4–L5 and L5–S1 being the most frequently affected levels, followed by multilevel involvement. The majority of patients were middle-aged women, often housewives, who experienced chronic lower back pain of moderate intensity, particularly during standing or walking. Comorbidities such as hypertension, diabetes, and osteoporosis were common, and overweight and smoking were also observed as contributory factors. Statistical analysis revealed a significant association between occupation and disc bulging, while no significant relationship was found with age, gender, or BMI, although BMI showed a near-significant trend. These results confirm that disc bulging is highly prevalent in the local population and emphasize the role of occupational stress, obesity, and systemic health conditions in its development. The study highlights MRI as an effective tool for early detection and risk assessment, reinforcing the need for preventive measures, lifestyle modification, and ergonomic adjustments to reduce the burden of lumbosacral disc bulging.

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