RESEARCH ARTICLE

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Incidental Degenerative Lumbar Disc Findings in Pediatric Patients: A Retrospective MRI Study Using the Pfirrmann Classification

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Abstract

Objectives: Degenerative intervertebral disc findings are well recognized in adults, but remain less clearly defined in pediatric patients, particularly when incidentally detected on magnetic resonance imaging (MRI). This study aimed to evaluate the prevalence, severity, and anatomical distribution of incidental degenerative lumbar disc findings in pediatric patients undergoing MRI for indications unrelated to degenerative spinal disease.

Methods: This retrospective observational study included 73 pediatric patients who underwent abdominal, pelvic, or lumbar MRI examinations with adequate visualization of the lumbar spine. Patients with known spinal trauma, previous spinal surgery, congenital spinal malformation, infection, malignancy, inflammatory spondyloarthropathy, or whose MRI was performed primarily for suspected degenerative spinal disease were excluded. Intervertebral discs were evaluated on sagittal T2-weighted images according to the Pfirrmann classification. Disc-level distribution, number of affected discs, Modic-type endplate changes, disc bulging, protrusion, and extrusion, and demographic variables were recorded.

Results: The study population consisted of 33 males (45.2%) and 40 females (54.8%), with a mean age of 11.8±4.2 years. Fifty-two patients (71.2%) had Pfirrmann grade 1 discs. Pfirrmann grade 2 and grade 3 degeneration were detected in 12 patients (16.4%) and 9 patients (12.3%), respectively. Overall, Pfirrmann grade 2 or higher disc degeneration was observed in 21 patients (28.8%). No Pfirrmann grade 4 or 5 degeneration was identified. Degenerative disc findings increased with age and were most frequent in the 13-17-year age group. No patient aged 6 years or younger showed disc degeneration. The affected levels were predominantly located in the lower lumbar spine, especially at L4-L5 and L5-S1. No marked sex-related differences were observed.

Conclusion: Incidental degenerative lumbar disc findings may be detected in pediatric patients, particularly during adolescence. These findings are usually low-grade, are limited to Pfirrmann grade 2 or 3 changes, and predominantly involve the lower lumbar levels. Awareness of this imaging spectrum may help radiologists avoid both underrecognition and overinterpretation of incidental degenerative disc findings in pediatric MRI.

Keywords: Pediatric MRI, lumbar spine, incidental findings, Pfirrmann classification, disc degeneration, intervertebral disc

Introduction

Magnetic resonance imaging (MRI) is widely used in the pediatric population because of its high soft-tissue contrast, multiplanar capability, and lack of ionizing radiation. Although spinal MRI is most commonly requested for specific clinical conditions such as low back pain, neurological deficits, trauma, scoliosis, infection, or suspected congenital abnormalities, the lumbar spine may also be partially or completely visualized during abdominal and pelvic MRI examinations performed for non-spinal indications. This has increased the detection of incidental vertebral and intervertebral disc abnormalities in children and adolescents.

Degenerative changes of the intervertebral discs and adjacent vertebral endplates are well-recognized findings in adults and are frequently detected even in asymptomatic individuals.[1,2] In the adult population, disc desiccation, disc height reduction, bulging, protrusion, annular fissures, and Modic endplate changes are common MRI findings, and their prevalence generally increases with age.[3-5] However, the presence and clinical significance of similar findings in pediatric patients remain less clearly defined. Because degenerative spinal disease is

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traditionally considered uncommon in children, these abnormalities may be overlooked or interpreted inconsistently when encountered incidentally.

Previous pediatric and adolescent MRI studies have shown that degenerative disc findings are not completely absent in younger age groups.[6-8] Low-grade disc signal alterations, early Pfirrmann grade changes, mild disc bulging, and rare Modic-type vertebral endplate signal abnormalities have been reported, particularly in older adolescents.[8,9] The lower lumbar levels, especially L4-L5 and L5-S1, appear more frequently involved, which may reflect the greater biomechanical load and mobility in these segments. Nevertheless, the reported prevalence varies considerably among studies because of differences in patient selection, imaging indication, age distribution, symptomatic status, and classification methods.

Standardized radiological classification systems are important for evaluating these findings objectively. The Pfirrmann grading system provides a reproducible method for assessing intervertebral disc degeneration based on disc signal intensity, disc structure, distinction between the nucleus pulposus and annulus fibrosus, and disc height.[10,11] Similarly, Modic classification allows systematic evaluation of vertebral endplate and adjacent bone marrow signal changes.[3,4] Using such grading systems in pediatric cohorts may help distinguish minimal age-related or developmental alterations from potentially relevant early degenerative pathology.

Despite the increasing use of MRI in children, limited information remains on the frequency and distribution of incidental degenerative vertebral and disc findings in pediatric patients undergoing MRI for indications unrelated to degenerative spinal disease. Most available data are derived either from symptomatic adolescents with low back pain or from asymptomatic adult populations. Therefore, evaluating pediatric patients who were scanned for indications that were neither spinal nor degenerative may provide a clearer estimate of the incidental burden of early degenerative spinal findings.

The aim of the present study was to assess the prevalence, severity, and anatomical distribution of incidental degenerative intervertebral disc and vertebral endplate findings in pediatric patients undergoing MRI for indications other than degenerative spinal disease. Particular attention was given to Pfirrmann grade distribution, number of affected disc levels, involved lumbar segments, Modic-type vertebral marrow changes, and associated findings such as disc bulging or herniation. This approach may improve awareness of early degenerative spinal findings in pediatric MRI and contribute to more accurate radiological reporting.

Methods

Study Design and Patient Population

This retrospective observational study included pediatric patients who underwent abdominal, pelvic, or lumbar magnetic resonance imaging examinations for indications unrelated to degenerative spinal disease. Ethical approval was granted by the Clinical Research Ethics CommiVee at Erzincan Binali Yıldırım University (approval no: 78924, date: 25.06.2026). Institutional approval was obtained before data collection, and the requirement for written informed consent was waived because of the retrospective nature of the study.

A total of 73 pediatric patients were included in the final analysis. Patients were eligible for inclusion if their MRI examinations adequately demonstrated the lumbar vertebrae and intervertebral disc levels from the upper lumbar region to the lumbosacral junction. Patients who underwent MRI primarily for suspected degenerative spinal disease, known spinal trauma, previous spinal surgery, congenital spinal malformation, spinal infection, malignancy, inflammatory spondyloarthropathy, or inadequate image quality were excluded from the study.

Demographic data, including age and sex, were obtained from the hospital information system. The clinical indication for MRI was also documented when available. Since the aim of the study was to evaluate incidental degenerative vertebral and disc findings, only patients without a primary clinical suspicion of degenerative lumbar spine pathology were included.

MRI Protocol

All MRI examinations were performed using a 1.5-T MRI scanner with standard body or spine coils, according to clinical indication. The imaging protocol varied slightly depending on whether the examination was performed for abdominal, pelvic, or spinal indications; however, only examinations that provided sufficient visualization of the lumbar vertebral column and intervertebral discs were included.

Sagittal T2-weighted images were used as the primary sequence for evaluating intervertebral disc signal intensity, disc height, disc morphology, and Pfirrmann grade. Sagittal T1-weighted images were evaluated for vertebral marrow signal characteristics and endplate-related changes. Axial T2-weighted images, when available, were used to confirm disc contour abnormalities such as bulging, protrusion, extrusion, or canal compromise. Fat-suppressed T2-weighted or STIR images were used to support the assessment of vertebral endplate edema or inflammatory-like marrow signal alterations when present.

Image Analysis

All MRI examinations were retrospectively reviewed by radiologists experienced in musculoskeletal and abdominal imaging. The readers evaluated the lumbar intervertebral discs and adjacent vertebral endplates by consensus. The following parameters were recorded: presence and grade of disc degeneration, number of affected disc levels, anatomical distribution of affected levels, presence of Modic-type endplate changes, disc bulging, disc protrusion, disc extrusion, disc height loss, and vertebral marrow or endplate abnormalities.

Each lumbar intervertebral disc was evaluated separately. Disc degeneration was graded according to the Pfirrmann classification on sagittal T2-weighted images.[10] In this grading system, grade 1 represents a normal disc with a homogeneous hyperintense signal, normal disc height, and a clear distinction between the nucleus pulposus and the annulus fibrosus. Grade 2 indicates preserved disc height with an inhomogeneous but still hyperintense signal. Grade 3 is characterized by inhomogeneous, intermediate or gray signal intensity and an unclear distinction between the nucleus and annulus, with disc height normal or only mildly decreased. Grade 4 represents advanced signal loss, characterized by hypointense disc signal, loss of distinction between the nucleus and annulus, and mild-to- moderate disc height reduction. Grade 5 indicates severe disc degeneration, with marked loss of disc height and a collapsed, hypointense disc.

For each patient, the highest Pfirrmann grade and the total number of affected disc levels were recorded. Discs classified as Pfirrmann grade 2 or higher were considered to show degenerative signal alteration.

Pfirrmann grades 4 and 5 were specifically recorded when present because these grades represent more advanced degeneration.

Vertebral endplate and adjacent bone marrow changes were assessed according to the Modic classification.[3,4]. Modic type 1 change was defined as low signal intensity on T1-weighted images and high signal intensity on T2-weighted or fat-suppressed images, compatible with edema-like inflammatory marrow change. Modic type 2 change is defined as high signal intensity on T1-weighted images and iso- to hyperintense signal on T2-weighted images, reflecting fatty marrow replacement. Modic type 3 change was defined as low signal intensity on both T1- and T2-weighted images, consistent with subchondral sclerosis.[5] The presence, type, and affected vertebral level of Modic changes were recorded.

Disc bulging was defined as a generalized extension of disc tissue beyond the margins of the vertebral body, involving a broad portion of the disc circumference. Disc protrusion was defined as focal or broad-based displacement of disc material in which the base of the displaced disc material was wider than its outward extension. Disc extrusion was defined as focal disc displacement in which the outward extension of the herniated material exceeded the width of its base. Sequestration was defined as displaced disc material with no continuity with the parent disc. Annular fissure, when visible as a focal high-intensity zone within the posterior annulus on T2-weighted images, was also recorded.

The anatomical level of each degenerative disc finding was categorized as L1-L2, L2-L3, L3-L4, L4-L5, or L5-S1. The distribution of affected levels was analyzed separately for Pfirrmann grade 2 and Pfirrmann grade 3 degeneration. Particular attention was given to lower lumbar levels because previous pediatric and adolescent MRI studies have suggested that early degenerative changes are more frequently observed at L4-L5 and L5-S1.[6,8]

Statistical Analysis

Statistical analysis was performed using standard statistical software. Continuous variables were expressed as mean ± standard deviation or median with range, depending on distribution characteristics. Categorical variables were summarized as frequencies and percentages. The prevalence of Pfirrmann grade 2 and grade 3 disc degeneration, Modic changes, disc bulging, protrusion, extrusion, and other vertebral or disc abnormalities was calculated as a proportion of the total number of patients.

The distribution of degenerative findings by sex and age group was evaluated when appropriate. Comparisons between categorical variables were performed using the chi-square test or Fisher's exact test. Continuous variables were compared using the independent samples t-test or Mann-Whitney U test, depending on the normality of their distributions. A p value of less than 0.05 was considered statistically significant.

Results

Demographic Characteristics of the Study Population

A total of 73 pediatric patients were included in the study. Of these, 33 patients were male (45.2%) and 40 were female (54.8%). The mean age of the study population was 11.8±4.2 years, with an age range of 3 to 17 years.

When patients were categorized according to age groups, 11 (15.1%) were 6 years of age or younger, 27 (37.0%) were between 7 and 12 years of age, and 35 (47.9%) were between 13 and 17 years of age. Degenerative disc findings were observed more frequently among adolescents. No patient aged 6 years or younger had Pfirrmann grade 2 or grade 3 disc degeneration (Figures 1-4).

Age and Sex Distribution According to Pfirrmann Grade

Fifty-two patients (71.2%) had Pfirrmann grade 1 discs and were considered to have no degenerative disc signal alteration. Pfirrmann grade 2 disc degeneration was detected in 12 patients (16.4%), and grade 3 in 9 patients (12.3%). No patient had Pfirrmann grade 4 or 5 degeneration.

Patients with Pfirrmann grade 2 or 3 degeneration were older than those with Pfirrmann grade 1 discs. The mean age was 10.6±4.1 years in patients with Pfirrmann grade 1 discs, 13.7±2.1 years in patients with Pfirrmann grade 2 degeneration, and 15.2±1.4 years in patients with Pfirrmann grade 3 degeneration. Degenerative findings were predominantly observed in patients aged 13-17 years.

No marked sex predominance was observed among patients with degenerative disc findings. Pfirrmann grade 2 degeneration was observed in 5 males and 7 females, while Pfirrmann grade 3 degeneration was observed in 4 males and 5 females.

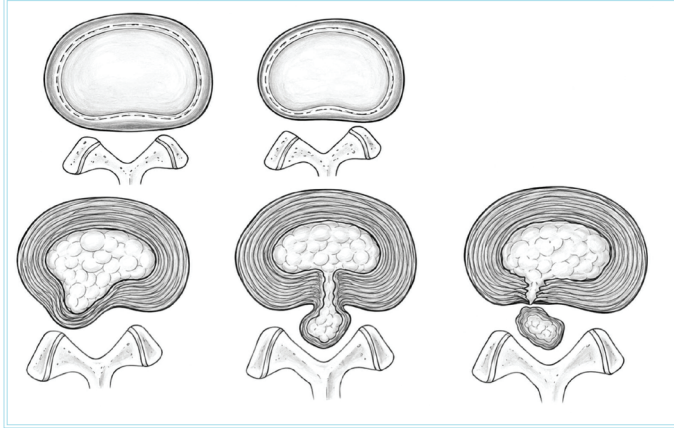

Figure 1. Schematic illustration of the Pfirrmann classification

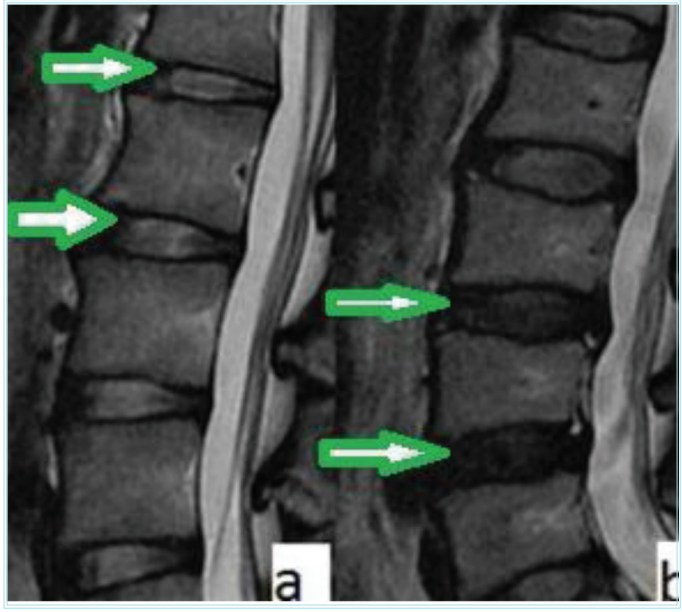

Figure 2. Pfirrmann grade 2 (**a**) and grade 3 (**b**) discs are shown (arrows)

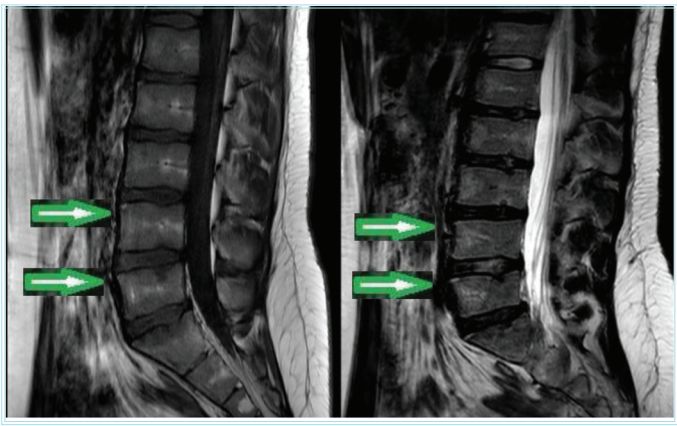

Figure 3. Modic type 2 degeneration is shown on sagittal T1-weighted and T2-weighted images, respectively

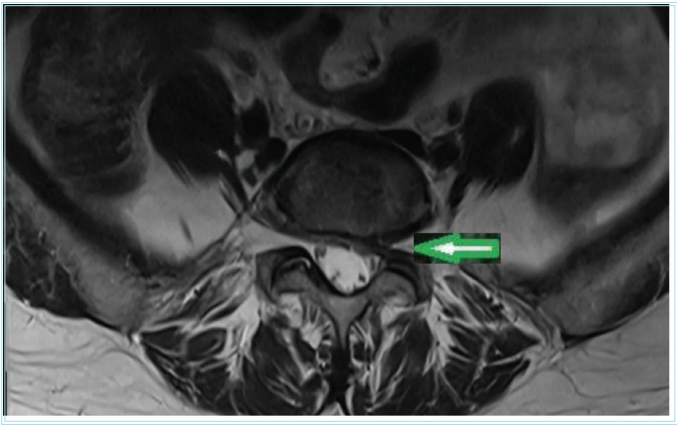

Figure 4. Disc bulging is shown on the T2-weighted

Overall, disc degeneration of Pfirrmann grade 2 or higher was detected in 21 of 73 patients (28.8%). The frequency and severity of disc degeneration increased with age. While no degenerative disc signal alteration was observed in children aged 6 years or younger, 5 of 27 patients (18.5%) in the 7-12-year age group and 16 of 35 patients (45.7%) in the 13-17-year age group demonstrated Pfirrmann grade 2 or 3 degeneration, respectively.

Among patients with degenerative disc changes, Pfirrmann grade 2 degeneration was slightly more frequent than Pfirrmann grade 3 degeneration. The distribution of degenerative changes did not show a clear sex-related difference. The affected disc levels and the number of involved discs are summarized separately for Pfirrmann grade 2 and grade 3 degeneration in Tables 1-4.

Among 73 pediatric patients, Pfirrmann grade 2 degeneration was detected in 12 patients (16.4%), and grade 3 in 9 patients (12.3%). No Pfirrmann grade 4 or 5 degeneration was identified. Degenerative disc findings were predominantly located in the lower lumbar spine, especially at L4-L5 and L5-S1.

Discussion

Incidental degenerative intervertebral disc findings were detected in 21 of 73 pediatric patients, corresponding to an overall prevalence of 28.8%. Pfirrmann grade 2 and grade 3 degeneration were observed in 12 patients (16.4%) and 9 patients (12.3%), respectively. No patient had Pfirrmann grade 4 or 5 disc degeneration. These findings indicate that degenerative disc signal alterations may be encountered in the pediatric population, although they are generally low-grade and rarely progress to advanced morphologic degeneration during childhood or adolescence.

Table 1. Demographic characteristics of the study population

Variable	n	%
Total number of patients	**73**	**100**
Sex		
Male	33	45.2
Female	40	54.8
Age group		
≤6 years	11	15.1
7-12 years	27	37.0
13-17 years	35	47.9
Age, years		
Mean ± SD	11.8±4.2	-
Range	3-17	-

SD: Standard deviation

Table 2. Distribution of Pfirrmann grades according to age and sex

Variable	Pfirrmann grade 1 n=52	Pfirrmann grade 2 n=12	Pfirrmann grade 3 n=9	Total n=73
Sex				
Male	24	5	4	33
Female	28	7	5	40
Age group				
≤6 years	11	0	0	11
7-12 years	22	4	1	27
13-17 years	19	8	8	35
Age, years				
Mean ± SD	10.6±4.1	13.7±2.1	15.2±1.4	11.8±4.2

SD: Standard deviation

Table 3. Distribution of patients with Pfirrmann grade 2 disc degeneration

Parameter	n	%
Number of affected discs per patient		
1 affected disc	9	12.3
2 affected discs	3	4.1
Total patients with Pfirrmann grade 2 degeneration	**12**	**16.4**
Affected disc level distribution		
L2-L3	1	1.4
L3-L4	2	2.7
L4-L5	6	8.2
L5-S1	6	8.2

Pfirrmann grade 2 degeneration was present in 12 of 73 patients (16.4%). The total number of affected disc levels was 15 because three patients had involvement at two levels

Table 4. Distribution of patients with Pfirrmann grade 3 disc degeneration

Parameter	n	%
Number of affected discs per patient		
1 affected disc	6	8.2
2 affected discs	2	2.7
3 affected discs	1	1.4
Total patients with Pfirrmann grade 3 degeneration	**9**	**12.3**
Affected disc level distribution		
L2-L3	1	1.4
L3-L4	2	2.7
L4-L5	5	6.8
L5-S1	5	6.8

Pfirrmann grade 3 degeneration was present in 9 of 73 patients (12.3%). The total number of affected disc levels was 13 because two patients had two-level involvement, and one patient had three-level involvement

The overall frequency of degenerative disc findings in our cohort is broadly consistent with previous pediatric MRI studies reporting that early degenerative spinal changes are not exceptional in children and adolescents, particularly when MRI examinations are reviewed systematically.[6-8] In the original study on which the present design was based, degenerative vertebral or disc-related findings were reported in approximately one-third of pediatric patients who underwent MRI for indications unrelated to degenerative spinal disease.[12] Similarly, previous studies have shown that low-grade disc signal changes, mild disc bulging, and vertebral endplate abnormalities may be incidentally detected in pediatric patients, although the reported prevalence varies according to age distribution, imaging indication, and diagnostic criteria.[7,9]

A noteworthy finding of the present study was the clear age-related distribution of degenerative changes. No patients aged 6 years or younger had Pfirrmann grade 2 or 3 degeneration, whereas degenerative disc changes were detected in 5 of 27 patients (18.5%) in the 7-12-year age group and 16 of 35 patients (45.7%) in the 13-17-year age group. This supports the concept that disc degeneration in pediatric patients is strongly age-dependent and becomes more apparent during adolescence.[6,7] The higher frequency in older children may reflect increasing axial load, greater spinal mobility, sports-related microtrauma, body growth, and progressive biochemical changes in the intervertebral disc matrix.[13]

The predominance of mild degeneration is another important finding. In our cohort, all degenerative discs were classified as Pfirrmann grades 2 or 3, and no advanced grades were observed. This pattern suggests that pediatric degenerative disc disease usually represents an early-stage imaging phenomenon rather than advanced structural failure. Pfirrmann grade 2 changes mainly reflect an inhomogeneous but still hyperintense disc signal with preserved disc height, whereas grade 3 changes indicate a more evident signal alteration with an unclear nucleus-annulus distinction but without marked disc collapse. Therefore, the absence of Pfirrmann grade 4 and 5 degeneration is compatible with the expected natural history of disc degeneration in a young population.

The anatomical distribution of affected disc levels also showed a consistent pattern. Both Pfirrmann grade 2 and grade 3 degenerative changes were more commonly observed at the lower lumbar levels, particularly L4-L5 and L5-S1. In the Pfirrmann grade 2 group, the most frequently affected levels were L4-L5 and L5-S1; each was involved in 6 disc levels. A similar pattern was observed in the Pfirrmann grade-3 group in which L4-L5 and L5-S1 were again the dominant levels. This lower lumbar predominance is biologically plausible because these segments are exposed to greater mechanical stress, higher mobility, and increased shear forces compared with upper lumbar levels. Similar lower lumbar clustering has also been emphasized in previous pediatric and adolescent MRI studies.[6,8,13,14]

In contrast to adult populations, in whom disc degeneration, disc height loss, bulging, protrusion, and Modic endplate changes are frequently encountered even in asymptomatic individuals, pediatric patients generally show fewer and milder degenerative abnormalities.[1,2] Adult MRI studies have demonstrated that degenerative findings increase substantially with age and may be present in a large proportion of individuals without back pain.[1,2] This creates an important interpretative issue: the presence of a degenerative imaging finding does not necessarily imply clinical relevance. The same principle should be applied carefully in pediatric imaging. Incidental low-grade Pfirrmann changes should be reported, but they should not be overinterpreted in the absence of concordant symptoms or other clinically significant abnormalities.

The lack of a marked sex-related difference in the present cohort is also consistent with the view that early pediatric disc degeneration is more closely related to age and segmental mechanical factors than to sex. Pfirrmann grade 2 degeneration was observed in 5 males and 7 females, while grade 3 degeneration was observed in 4 males and 5 females. Although the number of patients with degeneration was limited, these findings do not suggest a meaningful predominance of either males or females. Larger studies with balanced age and activity profiles would be required to determine whether sex, body mass index, physical activity, or sports participation modify the risk of early disc degeneration in pediatric patients.

The clinical significance of incidental degenerative disc changes in children remains uncertain. In symptomatic adolescents, disc degeneration and herniation may be associated with low back pain; however, in patients undergoing abdominal or pelvic MRI, or MRI for non-degenerative indications, these findings may simply reflect early structural adaptation or subclinical degeneration. Since the present study focused on incidental findings, radiological interpretation should be approached with caution. Low-grade Pfirrmann changes, particularly when isolated and unaccompanied by nerve root compression, marked disc height loss, or inflammatory endplate changes, may not require direct clinical intervention. Nevertheless, recognizing and documenting these findings may be useful for follow-up, especially in older adolescents or patients who later develop back pain.

Compared with the original 31-patient study, the present redesigned cohort preserves the same general radiological pattern but provides a broader sample size.[12] The original study reported Pfirrmann grades 2 and 3 degeneration in similar proportions and found no Pfirrmann grade 4 or 5 degeneration. In our expanded 73-patient dataset, the prevalences of Pfirrmann grades 2 and 3 degeneration remained comparable, and the overall rate of degenerative findings was 28.8%. This supports the internal consistency of the revised results and suggests that the new dataset remains compatible with the expected pediatric MRI spectrum.

Study Limitations

This study has several limitations. First, the retrospective design limits the ability to correlate imaging findings with detailed clinical symptoms, physical activity, body mass index, or longitudinal outcomes. Second, MRI protocols were not completely uniform because examinations were obtained for different clinical indications. Third, although the sample size was larger than that of the original study, subgroup analyses according to age, sex, and disc level remain limited by the relatively small number of patients with degenerative changes. Finally, because the study evaluated incidental findings, the true natural history and clinical consequences of these early disc abnormalities cannot be determined from these data.

Conclusion

Incidental degenerative disc findings can be detected in pediatric patients, particularly during adolescence. In the present cohort, these findings were predominantly low-grade, limited to Pfirrmann grades 2 and 3, and most frequently involved the lower lumbar levels, especially L4-L5 and L5S1. Advanced disc degeneration was not observed. These results support the view that early degenerative disc signal alterations are uncommon in younger children but become more visible in adolescents. Awareness of this imaging spectrum may help radiologists report pediatric lumbar MRI findings more accurately and avoid both underrecognition and overinterpretation of incidental degenerative changes.

Ethics

Ethics Committee Approval: Ethical approval was granted by the Clinical Research Ethics CommiVee at Erzincan Binali Yıldırım University (approval no: 78924, date: 25.06.2026).

Informed Consent: Due to the retrospective nature of the study, the requirement for written informed consent has been waived.

Footnotes

Authorship Contributions

Concept: Ö.Ç.A., Design: Ö.Ç.A., H.K.Ö., Data Collection or Processing: H.K.Ö., Analysis or Interpretation: H.E., Literature Search: Ö.Ç.A., H.E., Writing: Ö.Ç.A., H.K.Ö., H.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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