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Magnetic resonance imaging findings in Ghanaian patients presenting with low back pain: a single centre study

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Abstract

Background Due to the high prevalence of low back pain which impacts the lives of those affected, several studies have explored findings associated with the lumbar spine (which is the affected anatomy) using magnetic resonance imaging (MRI). This provides a better understanding of the pathology in the study setting and adds to the literature on the subject, which is useful during intervention and has implications for policymaking. However, there is a paucity of literature in the Ghanaian context. This study therefore explored the patterns of MRI findings in Ghanaian patients with low back pain.

Method A one-year retrospective cross-sectional design with a purposive sampling method was used to retrieve data from 59 MRI lumbar spine radiologist reports with a clinical history of low back pain. Data was analysed descriptively and inferentially. Inferentially, the Fisher's exact or chi-square (X^2) test was utilised to ascertain associations between variables where appropriate. Phi coefficient and Cramer's V were used to assess the strength of significant associations. Statistical significance was deduced at $p < 0.05$.

Results Among the reports identified, 57.6% ($n = 34$) were associated with females and 32.4% ($n = 25$) were associated with males. The mean age across reports was 44.7 ± 16.1 years. Disc degeneration (93.2%, $n = 55$) and lumbar spondylolysis (76.3%, $n = 45$) were the two main findings identified as the most prevalent across reports. The lordotic curvatures of patients with low back pain were predominantly normal (74.6% $n = 44$). Disc degeneration was strongly associated with L4/L5 ($V = 0.644$, $p = 0.001$).

Conclusion The prevalent finding identified was disc degeneration frequently located at L4/L5. Several other abnormal findings were identified. Age was significantly associated with lumbar spondylosis. Disc degeneration and lumbar spondylosis were more frequent between ages 30 and 70 years.

Clinical trial number Not applicable.

Keywords Low back pain, MRI, Lumbar spine, Disc degeneration

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Background

Low back pain (LBP) is now the leading cause of disability globally, and the most prevalent among all musculoskeletal conditions [1]. It is a pervasive health concern, affecting individuals of all ages and demographics [2]. By far, about 60–80% of the population will experience LBP at some point in their lives [2] with a significant proportion reporting persistent or recurrent symptoms that impact daily functioning, work productivity, and overall quality of life [3]. The prevalence of LBP worldwide is estimated to be between 30 and 80% among the general population and has been found to increase with age [4]. An annual prevalence of 57% has also been reported among a section of the African populace [5]. In Ghana, the prevalence of LBP in a rural setting was reportedly 15.7% [6].

As a crucial part of the musculoskeletal system, the lumbar spine, which consists of the five vertebrae (L1–L5), intervertebral discs, facet joints, ligaments, and muscles, provides the spinal cord and nerve roots with structural support, flexibility, and protection [7]. However, the lumbar spine is susceptible to various diseases that can result in LBP due to the complex interactions between its anatomical elements [8].

In the clinical evaluation of patients with LBP, diagnostic imaging may play a significant part in defining the underlying cause depending on the severity and physician assessment. Among the imaging modalities available, magnetic resonance imaging (MRI) has emerged as the preferred modality for assessing the lumbar spine due to its unparalleled soft tissue contrast and multiplanar imaging capabilities [9]. MRI enables detailed visualisation of the spinal anatomy, including the vertebral bodies, intervertebral discs, spinal cord, nerve roots, and surrounding soft tissues, allowing for the detection of a wide range of abnormalities contributing to LBP [10]. MRI findings associated with LBP include but are not limited to degenerative changes, facet joint arthropathy, spinal stenosis, neurogenic claudication, spondylolisthesis, and infections [11–13]. While several abnormalities could be present in the lumbar spine of patients with LBP many of these MRI findings are also present in people with no pain. This makes interpreting MRI findings of this pathology very difficult. As a result, radiologist reports which contain a detailed assessment provide an excellent opportunity to systematically analyse patterns of findings in patients [14]. In light of this, several studies have been conducted in different settings which offer a wealth of information that could aid interventions [15–20].

This is not the case in Ghana as there is a paucity of literature regarding this area. A study by Kyei et al. [21], sought to identify the prevalence and causes of LBP based on radiological reports. However, the study lacked emphasis on MRI findings although it reported that MRI and post-myelogram computed tomography appeared to be more diagnostic than plain X-rays. Furthermore, a more recent study regarding this context had limited focus where the authors investigated how facet joint arthrosis relates to LBP [22]. Thus, the patterns of MRI findings among patients with LBP in Ghana are unclear. This retrospective study therefore sought to investigate patterns of MRI findings in patients with LBP in a single centre in Ghana. Specifically, the objectives were to identify prevalent pathological findings and how they relate to age and the lumbar spine anatomy.

Methods

Study design, study site, population and sample size

A retrospective cross-sectional study design was used since it allows access to a large pool of readily available data [23, 24]. The study site was the Radiology Department of the Korle Bu Teaching Hospital which is the largest hospital in Ghana and arguably West Africa. Conclusive MRI radiologist reports of patients who presented for MRI lumbar spine examinations with histories of LBP from January 2023 to December 2023 at the hospital formed the study population, totalling 59. This eventually became the study sample as all were included in the study. A sample of the report can be identified in the supplementary sheet.

Sampling technique, inclusion and exclusion criteria

A non-probability purposive sampling method was employed as it intentionally highlights participants for a study based on the quality of interest [25]. Since this study considered MRI lumbar spine radiologist reports with a history of LBP, this form of sampling was best suited. The study included all radiologist reports of patients from January 2023 to December 2023 who underwent lumbar spine MRI examinations due to complaints of LBP in a consecutive manner. This was to avoid the potential of selection bias. MRI Radiologist reports of the lumbar spine with a history other than LBP and inconclusive reports i.e. reports lacking final impression or reports that were not completed by radiologist were excluded.

MRI protocol

Patients underwent MRI examination in a supine position using a 1.5 Tesla Toshiba Vantage Titan MRI machine with serial number GH-0029-01-CMR-01 and a surface coil. The standard lumbar MRI procedure was applied, which included stacked or contiguous axial T2 weighted, axial T1weighted turbo spin-echo sequences, 4-mm sagittal T1 weighted, coronal T2 weighted, sagittal T2 weighted, and short tau inversion recovery.

Data collection tool

A structured data collection sheet (Supplementary sheet) designed in Microsoft Excel (version 16) to capture relevant information from radiologist reports, including demographic details, clinical details, and MRI findings was applied. The structured sheet allowed for efficient data collection, enabling the researchers who are experts in the field to quickly extract pertinent information from radiologist reports without the need for manual transcription or interpretation. Sections on the sheet included age, gender, main finding, lumbar vertebrae involved, other findings per vertebrae, disc space involved, other findings per the disc space involved, region of termination of the spinal cord, and lordotic curvature. The data collection sheet was pilot-tested to ensure its reliability and validity in capturing the necessary information accurately [26].

Data collection procedure

Data was collected after ethical approval was granted and with permission from the management of the hospital's Radiology Department. The hospital's radiological data is stored on a picture archiving and communications system. Hence, with assistance from the information technology personnel and radiographers at the study site, the required data which were digital copies of conclusive radiologists' reports on all MRI lumbar spine scans were retrieved using a personal 32-gigabyte flash drive. The retrieved data was sorted to include only reports that meet the inclusion criteria. After, the relevant variables were extracted and inserted into the self-designed Microsoft Excel spreadsheet.

Table 1 Summary of the demographic data identified

Variable	Category	Frequency (*n*)	Percentage (%)	Total *n* (%)
Radiological reports	LBP	59	32.6	181 (100%)
	Non-LBP	122	64.1	
Gender	Females	34	57.6	59 (100.0%)
	Male	25	42.4	
Age group	10–19	2	3.4	59 (100.0%)
	20–29	7	11.9	
	30–39	15	25.4	
	40–49	13	22.0	
	50–59	10	16.9	
	60–69	8	13.6	
	70–79	3	5.1	
	80–89	1	1.7	
Spinal cord termination	T12	3	5.1	58 (98.3%)
	T12/L1	3	5.1	
	L1	32	54.2	
	L1/L2	7	11.9	
	L2	11	18.6	
	L2/L3	2	3.4	
Lordotic curvature	Normal	44	74.6	57 (96.6%)
	Kyphotic deformity	1	1.7	
	Loss of Lordotic curve	3	5.1	
	Straightening	9	15.3	

NB: Only 58 and 57 of the reports included spinal cord termination and lordotic curvature respectively. **LBP** = low back pain

Data analysis

Data analysis was conducted with the statistical package for social sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA) and Jamovi 2.5.6. Both descriptive and inferential statistics were employed in this study. To harness the analysis, the extracted main and other abnormal findings were re-coded as either positive or negative to depict their presence or absence across reports. Descriptive statistics was used to describe the data set using bar graphs and tables to present frequencies of various variables. The Fisher's exact test or chi-square goodness of fit (X^2) was used to ascertain associations between variables where appropriate. Additionally, Phi coefficient and Cramer's V were used to assess the strength of significant associations. A coefficient above 0.25 was deemed a strong association [27]. Statistical significance was deduced at $p < 0.05$.

Ethical approval and consent to participate

This study was approved by the Ethics Committee of the University of Ghana, School of Biomedical and Allied Health Sciences (SBAHS/AA/RAD/10918774/2023–2024). Informed consent to participate was waived by the ethics committee except for those whose radiological images were included, of which informed consents were duly obtained. To ensure the confidentiality and anonymity of the patients whose reports were included in the data extraction process, identification numbers were used instead of the patient's name, also all patients' and radiologists' names on reports were blacked out by using the highlighter tool in Microsoft Word 2016 and setting the colour to black.

Results

Distribution of radiological reports and demographic data

From Table 1, it was identified that the majority (57.6%, $n = 34$) of the reports belonged to females. The most predominant age group identified was 30–39 years (25.4%, $n = 15$) although the overall mean age and standard deviation was 44.7 ± 16.1 years. The most prevalent region in the lumbar anatomy where the spinal cord terminated was reported to be the first lumbar vertebrae (L1) (54.2%, $n = 32$). The lordotic curvatures reported were predominantly normal (74.6%, $n = 44$).

Distribution of main pathological findings

As shown in Table 2, the two main findings identified across reports were disc degeneration and lumbar spondylosis. The most prevalent among the two was disc degeneration (93.2%, $n = 55$) followed by lumbar spondylosis (76.3%, $n = 45$). Further, these two major findings co-existed for the majority of the time per reports such that all reports having lumbar spondylosis also had disc degeneration (76.3%, $n = 45$). This association using Fisher's exact test and Cramer's V was significant and strong ($p = 0.038$, V = 0.325). Representative MRI images of disc degeneration and spondylosis are shown in Figs. 1 and 2.

Table 2 Summary of the distribution of main pathological findings

Main finding		**Frequency (*n*)**	**Percentage (%)**	**Total *n* (%)**
Finding	**Category**			
Disc degeneration	Positive	55	93.2	59 (100.0%)
	Negative	4	6.8	
Lumbar spondylosis	Positive	45	76.3	59 (100.0%)
	Negative	14	23.7	

Disc degeneration * Lumbar spondylosis crosstabulation

		Lumbar spondylosis		**Total n (%)**	***p*-value**	**V**
		Negative	**Positive**			
Disc degeneration	Negative (n) %	3 (5.1%)	1 (1.7%)	4 (6.8%)	0.038	0.325
	Positive (n) %	11 (18.6%)	44 (74.6%)	55 (93.2%)		
Total		14 (23.7%)	45 (76.3%)	59 (100.0%)		

Positive = present on report **Negative** = absent on report **V** = Cramer's V **p-value** = Fisher's exact

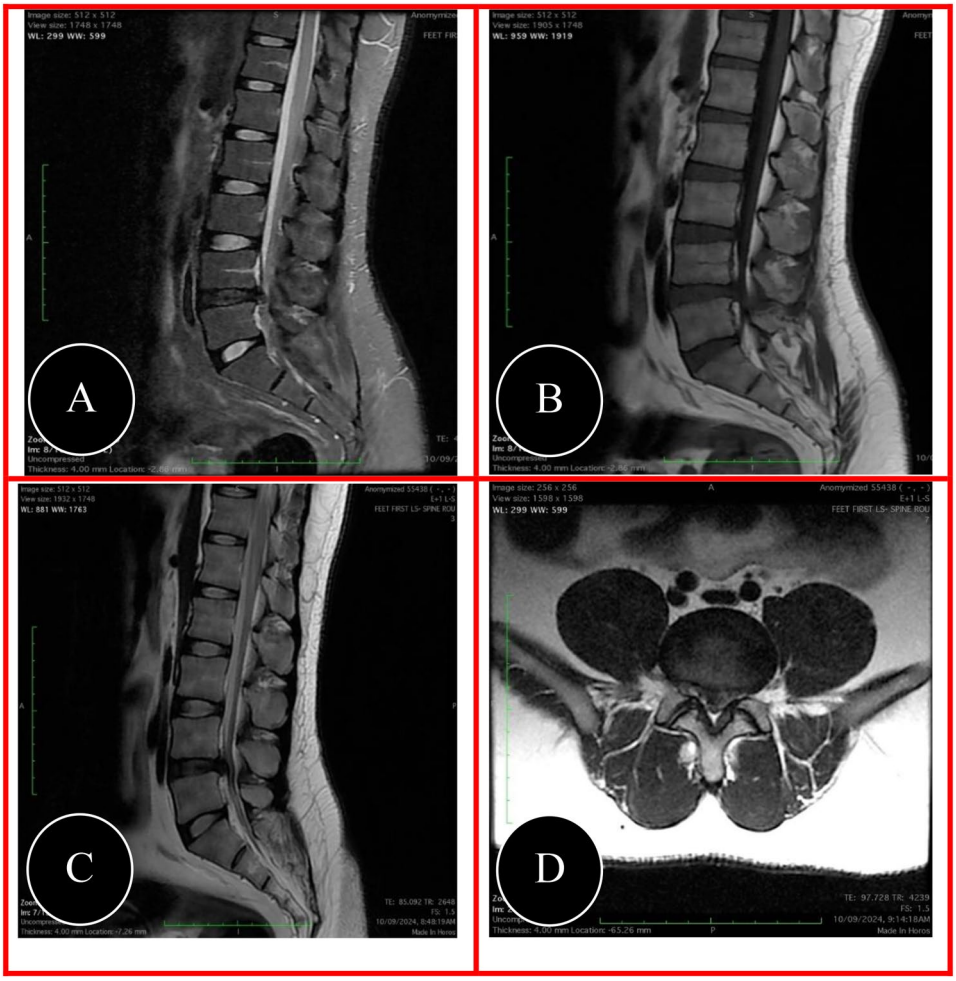

Fig. 1 Sagittal STIR (**A**), T1 (**B**) and T2 (**C**) and Axial T2 (L4/L5 level) (**D**) MRI images of the lumbosacral region depicting diffuse bulging of the L4/L5 degenerative disc causing severe spinal canal stenosis and compression of the L5 transverse nerves

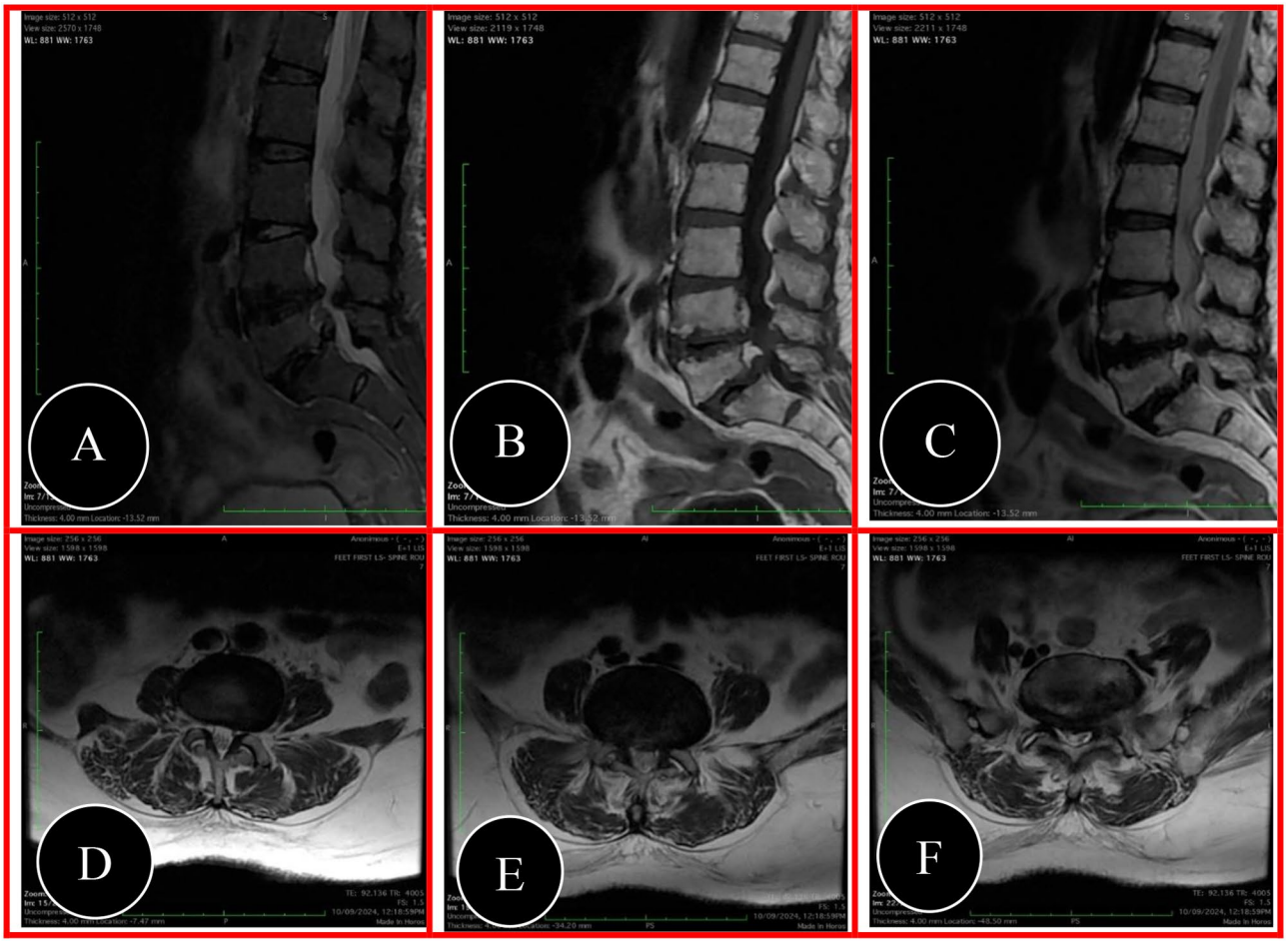

Fig. 2 Sagittal STIR (**A**), T1 (**B**) and T2 (**C**), and Axial T2 (L3/L4, L4/L5 and L5/S1 Levels) (**D**-**F**) MRI images of the lumbosacral region depicting spondylosis with multilevel degenerative disc disease involving the L3/L4, L4/L5 and L5/S1 intervertebral discs. These are worst at the L4/L5 and L5/S1 Levels where there is spinal canal stenoses, neural foramina narrowing with nerve root compressions

Distribution of intervertebral discs with disc degeneration

It was identified (Fig. 3) that the lumbar disc space most affected by disc degeneration across reports in descending order was L4/L5 (89.8%, $n = 54$), L5/S1 (86.4%, $n = 52$), L3/L4 (76.3%, $n = 45$), L2/L3 (71.2%, $n = 42$) and L1/L2 (69.5%, $n = 41$). This associated trend was significant such that the intervertebral disc region with the strongest association (Cramer's V) in descending order followed the same trend.

Distribution of pathologies arising from disc degeneration per intervertebral disc

Overall, 8 pathologies were identified (Fig. 4) which included inter-disc height reduction, facet joint arthrosis, enlarged ligamentum flava, anterior theca indentation, spinal canal stenosis, neural foramina narrowing, nerve root compression, and cauda equina stenosis. Among these, facet joint arthrosis was the most prevalent, given its high prevalence in all the intervertebral disc spaces (L1/L2 = 64.4%, L2/L3 = 54.2%, L3/L4 = 49.2%, L4/L5 = 52.5% and L5/S1 = 64.4%) across reports. Further, facet joint arthrosis was significantly associated with L1/L2 to L5/S1. Accordingly, the intervertebral disc space with the strongest association was L1/L2 (V = 0.891) with L4/L5 having the least strong association (V = 0.320). On the contrary, neural foramina narrowing was significantly associated with all but L1/L2 intervertebral disc space with L3/L4 having the strongest association (V = 0.567).

Distribution of findings regarding vertebral bodies

The vertebral body across reports with the highest frequency of abnormality (Fig. 5) in descending order were L5 (61%, $n = 36$), L4 (59.3%, $n = 35$), L3 (55.9%, $n = 33$), L2 (44.1%, $n = 26$) and L1 (37.3%, $n = 22$). Lumbar spondylosis was significantly associated with all the lumbar vertebrae except L1 (Fig. 6) with the strongest associations noted at L5 (Phi = 0.453) and L4 (Phi = 0.430). Four abnormal findings (Fig. 7) were identified relating to the vertebral bodies which included osteophytes, Schmorl's node, vertebral height reduction and intraosseous lipoma.

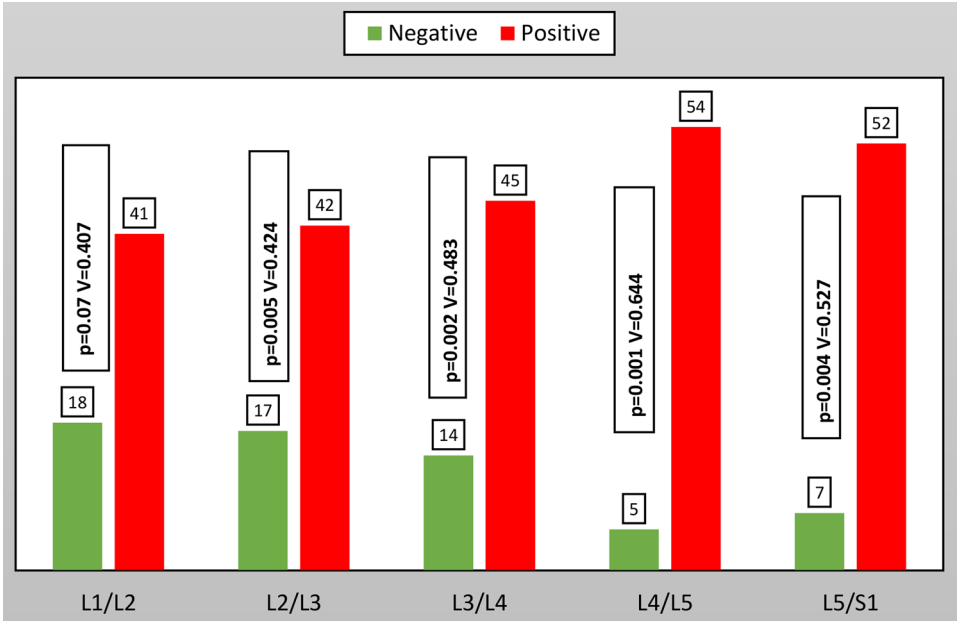

Fig. 3 A bar graph of the distribution of intervertebral disc with disc degeneration. NB: the frequencies for each represent the total number identified across reports. P-values were from Fisher's exact

Osteophytes were the most prevalent abnormality identified per their frequency on the five lumbar vertebras, with L3 (52.5%, $n=31$) and L4 (52.5%, $n=31$) being the regions with the most frequency. This was followed by Schmorl's node, with L5 (10.1% $n=6$), vertebral height reduction, occurring most often in the L4 region (13.6%, $n=8$) and intraosseous lipoma.

Association between main findings and age

A trend was observed where the frequency of disc degeneration rose across the age groups, peaked at 30–39 years, and began to dwindle. This association was insignificant ($p=0.055$). However, disc degeneration had higher frequencies between ages 30 and 70 years. Also, lumbar spondylosis had higher frequencies as age increased such that between ages 30 and 70 years, lumbar spondylosis was more prevalent. Below age 30 lumbar spondylosis was rare. This association was significant ($p=0.004$). These are summarised in Fig. 8.

Discussion

Most LBP cases were females with a male-to-female ratio of 0.74:1 relatable in the context of LBP [28]. The possible reasons could be hormonal factors, anatomical differences, and psychosocial factors among others [29]. Hormonal fluctuations, particularly in postmenopausal women, are known to affect bone density and spinal health, potentially contributing to higher LBP prevalence among females [29]. Additionally, females may be more likely to report pain or seek medical care, further skewing the observed ratio [30]. However, these factors do not fully explain the above disparity [31, 32]. It was also revealed that the age group with the most LBP was between 30 and 70 years comparable to other studies and reports [1, 33].

Regarding the lordotic curvatures, the majority of the reports revealed a normal curvature. In the literature, the relationship between lumbar lordosis and LBP is indeed complex and remains a subject of ongoing debate. Although some studies indicate that a reduced lumbar lordotic angle may be associated with LBP, particularly in cases involving disc herniation or degeneration [34], the evidence is far from conclusive. Other research [35], found no significant correlation between lumbar lordotic angle and the occurrence of LBP. This inconsistency could be attributed to various factors, including age, gender, body mass index, and ethnicity, which are known to influence lumbar lordosis [36]. Hence, further research is imperative in this area.

Two main abnormalities identified in this study were disc degeneration and lumbar spondylosis of which the most prevalent was disc degeneration (Table 2). The finding regarding the prevalence of disc degeneration is comparable to a similar study conducted in Nepal which found disc degeneration was the most prevalent finding [15]. However, the findings contradict a study conducted in Nigeria which reported disc prolapse as the most prevalent finding [37]. A possible explanation is the difference in the study setting and inclusion criteria of the studies. In Iyidobi et al. [37], the study setting was an orthopaedic hospital and MRI reports were from patients who needed surgical intervention. Interestingly all reports

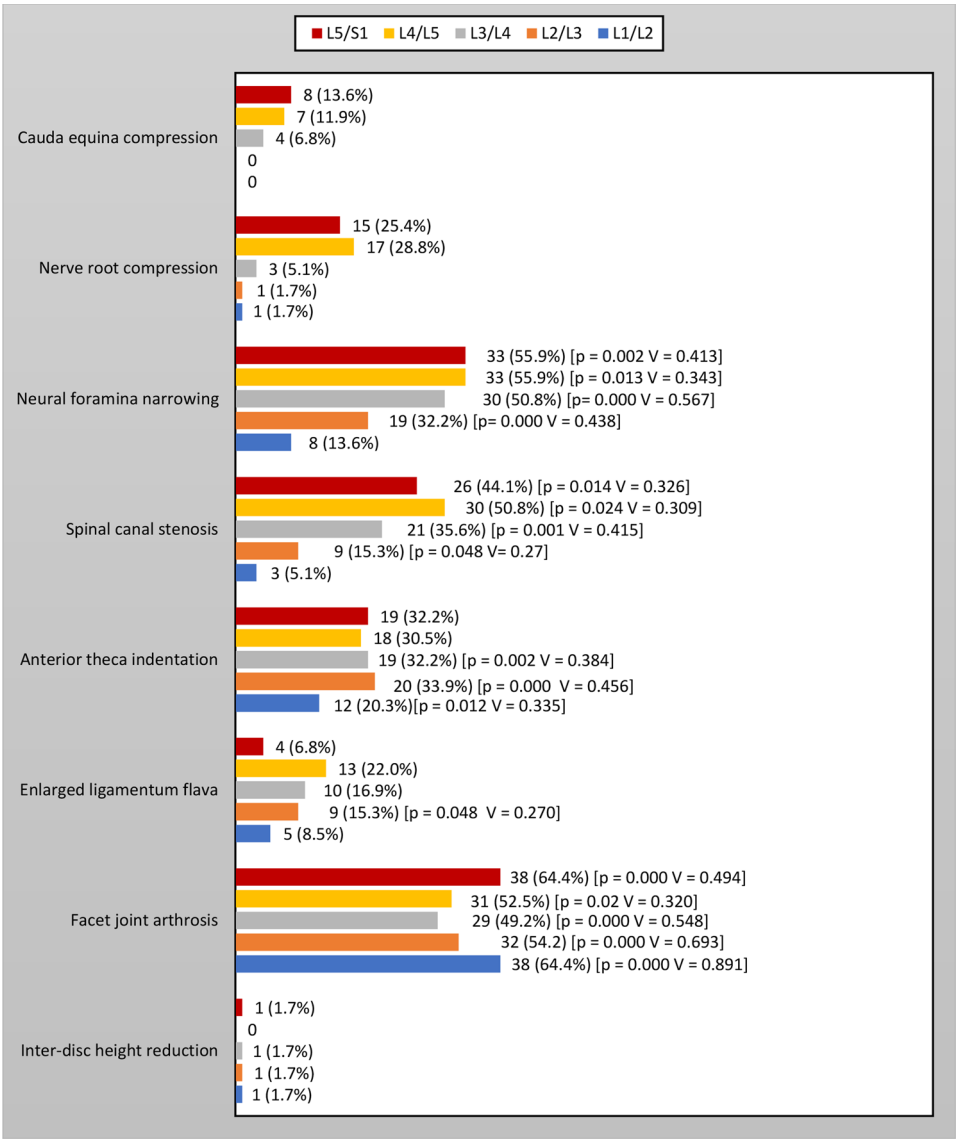

Fig. 4 A bar graph of the distribution of pathologies arising from disc degeneration per inter-disc. NB: the frequencies for each represent the total number identified across reports. The p-values were from Fisher's exact

where spondylosis was identified also had disc degeneration showing a significant association between the two pathologies (Table 2). This suggests that regarding patients with LBP, disc degeneration may be a precursor or contributing factor to the development of spondylosis and vice versa. According to Middleton and Fish [38], degeneration of the intervertebral discs often results in structural changes in the spine, such as osteophyte formation and disc space narrowing, which are characteristic of spondylosis.

This study revealed that the commonest intervertebral disc space where disc degeneration frequently occurred was L4/L5 followed by L5/S1 (Fig. 3) indicating that the lower intervertebral segments especially L4/L5 is the most affected by disc degeneration in this study regarding LBP. Again, the fact that this same region in this study had a strong association with the abnormality (Fig. 3) speaks volumes about its vulnerability to degenerative changes. These findings are consistent with similar studies [20, 37, 39]. According to Liyew [40], more than 80% of lumbar disc degeneration occurs at L4/L5 and L5/S1. Regarding this, Ghanaian clinicians should pay special attention to the L4/L5 and L5/S1 regions when diagnosing and managing lumbar spine disorders in patients with LBP. Further, the eight abnormalities identified as causative by disc degeneration (Fig. 4) showcase how various abnormalities arise from disc degeneration regarding LBP. In particular, facet joint arthrosis was the most prevalent finding which is unsurprising as its occurrence is strongly associated with disc degeneration [41] similarly

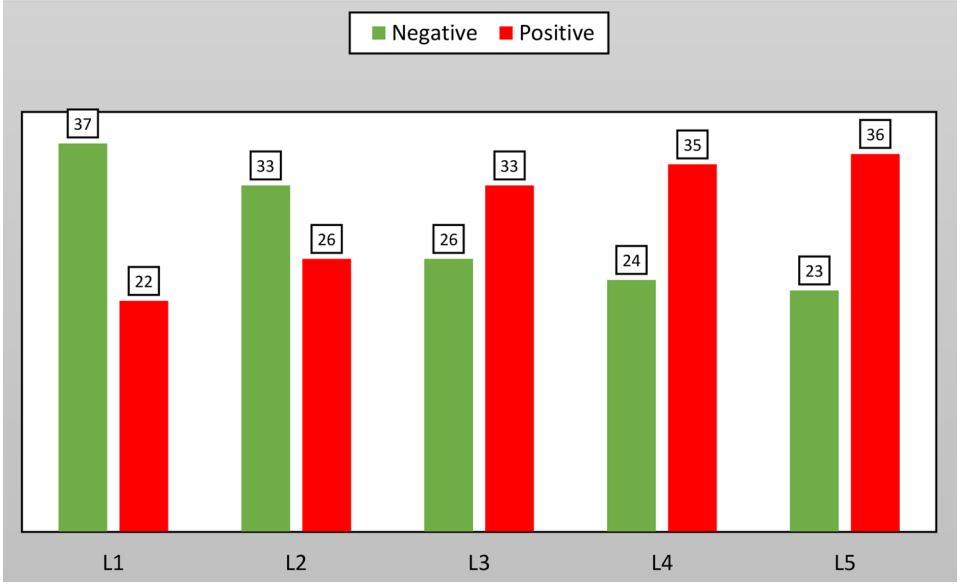

Fig. 5 A bar graph of the distribution of vertebral bodies with pathologies. NB: the frequencies for each represent the total number identified across reports

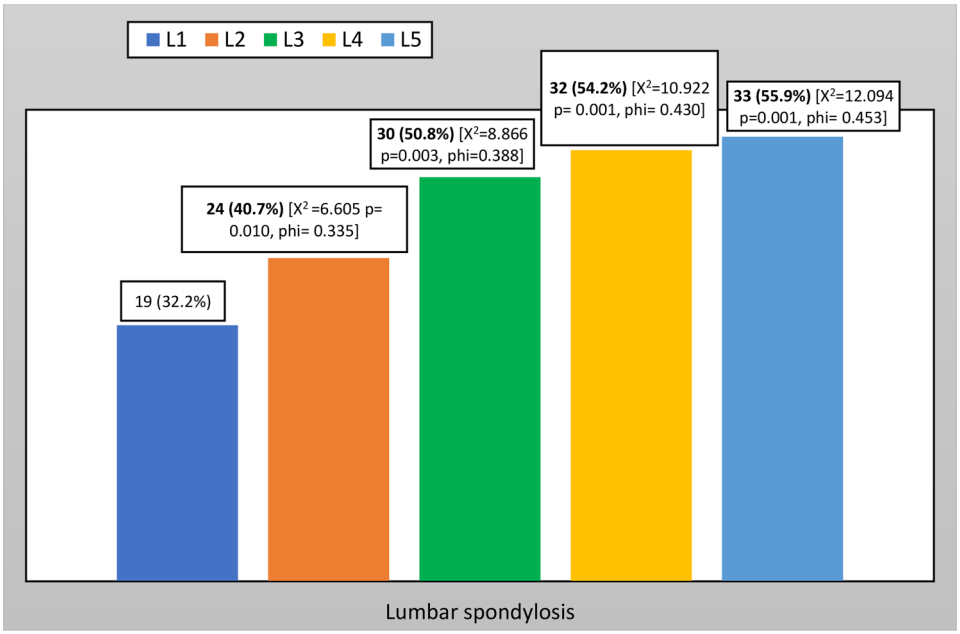

Fig. 6 A bar graph of the association between lumbar vertebrae and spondylosis. NB: the frequencies for each represent the total number identified across reports. X^2 = chi-square test

identified in this study. The other three most prevalent findings were neural foramina narrowing, anterior theca indentation, and spinal canal stenosis.

Among the four abnormalities identified in the lumbar vertebrae, osteophytes were the most common, particularly affecting L3 and L4 the most (Fig. 7). However, since lumbar spondylosis is associated with osteophytes [38], was prevalent (Table 2) and has a strong association with the vertebrae bodies, this finding is expected. Following this, Schmorl's nodes were frequently found, especially in the L5 region. The detection of Schmorl's nodes aligns with research that suggests Schmorl's nodes play a role in LBP. In a Turkish study [42], Schmorl's nodes were found in nearly one-third of patients with LBP and also correlated with severe disc degeneration and Modic changes in the upper and lower lumbar vertebrae. The detection of Schmorl's nodes in this study potentially suggests the need for Ghanaian clinicians to consider them

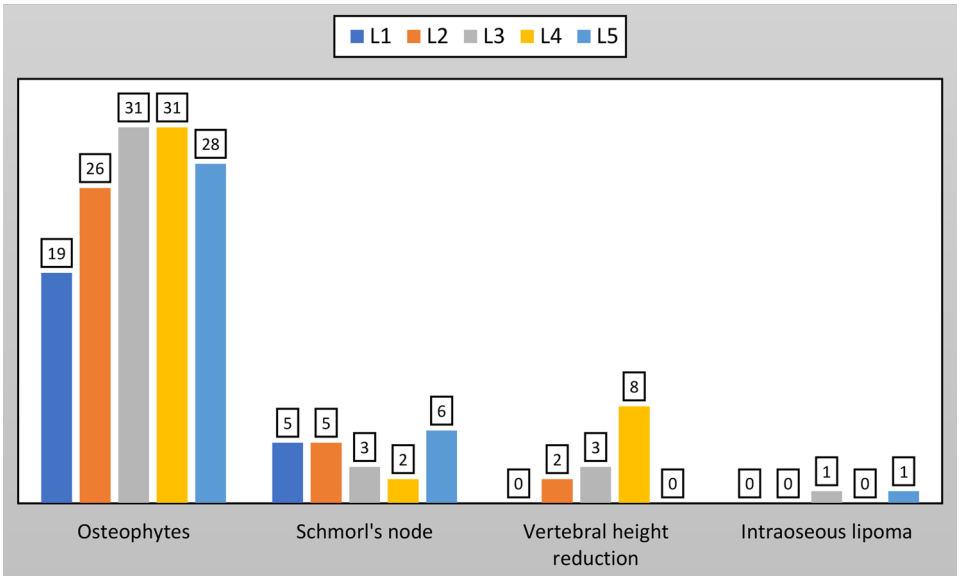

Fig. 7 A bar graph of the distribution of pathologies associated with vertebral bodies per vertebral bodies. *NB: the frequencies for each represent the total number identified across reports*

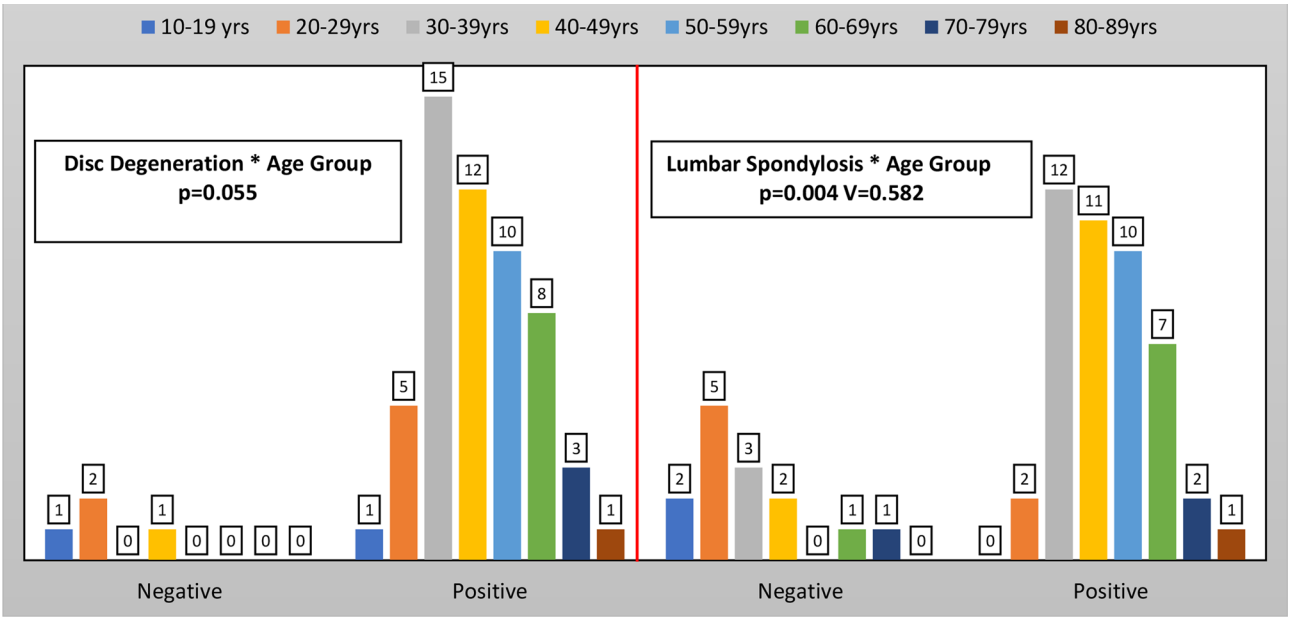

Fig. 8 A bar graph of the association between main findings and age. *NB: The p-value was from Fisher's exact test*

as potential contributors to LBP, especially in the lower lumbar spine, where mechanical loading is highest. Vertebral height reduction, another notable abnormality, was predominantly observed at L4. The least common abnormality identified was intraosseous lipoma which is consistent with the literature in terms of its rareness as a bone-related pathology mostly identified by incident [43].

Although statistically insignificant, the study revealed an intriguing trend in the occurrence of disc degeneration across age groups. The frequency of disc degeneration rose with age, peaking between 30 and 39 years, and then gradually declined (Fig. 8). By far, disc degeneration is globally known to increase with age and not to decline. For instance, a Japanese study [44] analysing intervertebral disc degeneration across different ages in the context of LBP found that disc degeneration significantly increases with age in both men and women. Therefore, a possible explanation could be the overwhelmingly high prevalence of disc degeneration in the sample (Table 2) and the study's small sample size. While

the high prevalence across age groups possibly reduced the variability necessary to detect statistically significant age-related differences, the small sample size further limited statistical power.

Furthermore, the two age groups from this trend (Fig. 8) where disc degeneration was predominant was 30 to 39 years and 40 to 49 years (Fig. 8). Many Ghanaians have long been reported to indulge in informal labour [45, 46], some of which are described as menial. According to an Australian study [47] this form of labour can have negative implications on their low back like pain. This, coupled with recent statistics by the Ghana statistical service [48], which suggest that it is around this age groups that peak physical work activity is noted among the Ghanaian population possibly affirms this finding. This is because studies have reported that high occupational loading due to high physically demanding work activity increases the accumulation of stress on the spine which accelerates degenerative changes [49, 50].

Age was identified to be significantly associated with lumbar spondylosis (Fig. 8) in the context of LBP comparable to a Japanese study [51]. Hence the finding that, age group 30 to 39 years coincided with the emergence of lumbar spondylosis, such that it was more prevalent between ages 30 and 70 and was rare below age 30 was unsurprising.

It must be noted that, the relationship between MRI findings and back pain is still unclear. For instance, meta-analysis comparing MRI findings in back pain [52] and neck pain [53] report some associations between MRI findings and pain, but there were also studies showing existence of these findings in pain free individuals. So, although findings identified were in relation to MRI of the lumbar spine for low back pain, the studies cross sectional nature can't make inference about whether the MRI findings are the cause of the patients' pain. Further studies will be appropriate in this regard.

Limitations and recommendation

Given the small sample size and the single-centre nature of this study, caution is required when making generalisations. The limited sample size was due to frequent MRI machine breakdowns at the center. Although the authors attempted to include reports from other nearby private facilities to expand the dataset, these efforts were unsuccessful. Additionally, the lack of access to patients' electronic medical records restricted the inclusion of diverse clinical presentations, limiting further inclusion criteria and comprehensive data analysis. Despite these challenges, reports were selected consecutively, ensuring that all cases with clinical history of LBP were included. Future studies should consider a multi-centre approach, expanding data collection to other regions of Ghana and extending study durations to enhance generalisability. Again, incorporating additional clinical variables could allow for kore in-depth data analysis. Further research should explore the relationship between MRI findings and low back pain to provide a more comprehensive understanding of this condition in the Ghanaian setting.

Conclusion

The prevalent finding identified was disc degeneration frequently located at L4/L5. Several other abnormal findings were identified. Age was significantly associated with lumbar spondylosis. Disc degeneration and lumbar spondylosis were more frequent between ages 30 and 70 years.

Abbreviations

LBP	Low back pain
MRI	Magnetic resonance imaging
L1	First lumbar vertebrae
L2	Second lumbar vertebrae
L3	Third lumbar vertebrae
L4	Fourth lumbar vertebrae
L5	Fifth lumbar vertebrae
L1/L2	First and second lumbar disc space
L2/L3	Second and third lumbar disc space
L3/L4	Third and fourth lumbar disc space
L4/L5	Fourth and fifth lumbar disc space
L5/S1	Fifth lumbar and first sacral disc space

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12880-025-01680-7.

Supplementary Material 1

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Author contributions

G.A. contributed to the conceptualisation, design, data acquisition, analysis, interpretation of data, final draft and revision. D.S.A. contributed to the conceptualisation, design, data acquisition, analysis, interpretation of data, final draft and revision. L.F. contributed to the conceptualisation, design, data acquisition, analysis, interpretation of data, final draft and revision. K.A.K. contributed to the analysis, interpretation of data, final draft and revision. J.L.A. contributed to the analysis, interpretation of data, final draft and revision. DA contributed to the data acquisition, analysis, interpretation of data, final draft, interpretation of Figs. 1 and 2 and revision. W.K.A. contributed to the final draft and revision.

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Data availability

The data sets used and analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval

Following the Helsinki protocol, this study was approved by the ethics committee of the University of Ghana, School of Biomedical and Allied Health Sciences (SBAHS/AA/RAD/10918774/2023–2024).

Consent for publication
Consent for publishing radiological data was sought from the participants.

Competing interests
The authors declare no competing interests.

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