

Magnetic Resonance Imaging of Lumbosacral Intervertebral Discs in Nigerians with Low Back Pain

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is the modality of choice in diagnostic imaging of the neurological structures related to low back pain (LBP). Particularly, in evaluation of the vertebral discs, its relationship to the nerve roots and related structures with precise diagnosis that guides the patient's management. This study evaluated the spectrum of intervertebral disc findings in LBP patients at two imaging centers in the South-West and North-Central Nigeria. Association between the clinical diagnosis and MRI disc findings was tested. **Materials and Methods:** This is a retrospective descriptive study. The request cards, reports, and available recorded images of patients referred for MRI for LBP from 2013 till 2015 were retrieved. The extracted patients' information, radiological findings were documented in a data form, with due compliance to confidentiality of the cohort and analyzed by Statistical Package for Social Sciences (SPSS) software (Version 20.0., IBM Corp. Released 2011, IBM SPSS Statistics for Windows, IBM Corp. Armonk, NY, USA) Results were presented as tables and test of association between variables carried out using Pearson *t*-test. **Results:** A total number of 205 patients were enrolled. Age range of the subjects was 10–83 years and mean age = 52.5 ± 15.4 years. There were more females with a male to female ratio of 1:1.04. LBP was more common in the fifth decade and least in ≤ 20 years (3%). MRI disc abnormalities increased with advancing age with statistically significant association between disc abnormalities and the patient's age, lumbar spondylosis, disc prolapse, and spinal canal stenosis. **Conclusion:** Disc abnormalities increased significantly with advancing age. Lumbar spondylosis, disc prolapse, and spinal canal stenosis are most commonly associated with florid disc abnormalities on MRI.

Key words: Abnormalities; disc changes; low back pain; magnetic resonance imaging; spondylosis

Introduction

Low back pain (LBP) is a common presenting complaint among adults in hospitals throughout the World, being one of the most common symptoms-related reason for visits to the hospitals.^[1-3] LBP affects more than 70% of the population in developed countries and poses a major socioeconomic burden.^[4] LBP is a frequent cause of work-related disability in people under 45 years of age and documented as the most expensive causes of work-related disability in term of workers' compensation and medical expenses.^[1,3] LBP affects

men and women equally, with onset most often between the ages of 30 and 50 years. It is also relatively common in young individuals^[3,5-7] and has been documented to begin in childhood and during early teenage years.^[8-10]

LBP is defined as pain perceived as arising from anywhere within a region bounded superiorly by an imaginary transverse line through the tip of the last thoracic spinous process, inferiorly by an imaginary transverse line through the tip

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of the sacrococcygeal joints and laterally through the lateral borders of the lumbar erector spinae muscle and passing through to the posterior-superior and posterior-inferior iliac spines.^[11]

The lumbosacral spine consists of the bony vertebral column and cartilaginous discs that support ligaments, muscles, joints, soft tissues, and nerve tissues. The spine not only supports the weight of the head and torso, it also supports the spinal cord nerve roots, sensory and autonomic ganglia, and peripheral nerves. Nearly all of these tissues of the spine have sensory innervations and are capable of producing pain and other sensations.^[12]

Experimental studies suggest that LBP may originate from many spinal structures, including ligaments, facet joints, the vertebral periosteum, the paravertebral musculature and fascia, blood vessels, the annulus fibrosus, and spinal nerve roots.^[3] Causes of LBP are numerous but the most common causes are musculoligamentous injuries and age-related degenerative processes in the intervertebral disc and facet joints. Among older patients, over 65 years of age, neoplasm, compression fractures from osteoporosis and aortic aneurysm are the common causes.^[3]

Spinal canal stenosis due to hypertrophic degenerative processes and degenerative spondylolisthesis are more common in older people. However, 85% of patients with isolated LBP cannot be given a precise pathoanatomical diagnosis,^[3] thus nonspecific terms, such as sprain or strain or degenerative processes are commonly applied.^[2]

LBP may be acute (lasting 3–6 weeks)^[13] or chronic, lasting for more than three to six months or more) with intermittent exacerbations.^[14,15]

Although good history and detailed clinical examination are important in the diagnosis of the causes of LBP. Radiological imaging is the most important investigation crucial for accurate diagnosis, preoperative work-up, and follow-up of patients with LBP.^[16] Various imaging modalities for the evaluation of LBP include plain radiography, myelography, computed tomography, nuclear medicine, discography, and magnetic resonance imaging (MRI).

MRI has emerged as the investigation of choice in diagnostic imaging of the neurological structures related to LBP among all imaging modalities.^[17] MRI gives better anatomical detail of soft tissue, spinal cord, and the nerve roots. It shows the relationship of the disc to the nerve and locates soft tissue and nonbony structures. Its multiplanar imaging capability allows axial, sagittal, and coronal image acquisition with ease. It is also ionizing radiation-free.

Several studies have been done on MRI evaluation of LBP in developed countries such as United States and Denmark

and also in Malaysia.^[16-20] However, in Nigeria, few studies have been done on MRI. This is primarily due to availability of magnetic resonance imaging equipments in few centers and the associated high cost of MRI investigation. The previous studies in Nigeria were single center studies with small population size.^[21-23] Due to these reasons and the high incidence of LBP in our population, we aimed at conducting a two center study on MRI evaluation of the lumbosacral spine intervertebral disc among Nigerians with LBP in centers in the Southwestern and North central Nigeria. We sought to find the pattern/spectrum of MRI disc findings of the lumbosacral spine in patients with LBP among a much larger study population and geographical spread in Nigeria. These findings were compared with those already published by similar studies in literature. We also determined the correlation between the clinical symptoms and intervertebral disc MRI pathologies in our subjects.

Materials and Methods

This is a retrospective and a descriptive two center MRI study of the lumbosacral spine discs in patients referred for MRI due to LBP from the South Western and North central Nigeria at Institutions where the MR is available and functional.

All patients that had lumbosacral spine MRI only for LBP in 2010, and April 2013–August 2015 at the two centers were included in this study. All the request cards, imaging reports, and recorded images were retrieved. Patients' information including their bio data, clinical indications, and radiological findings were documented into a prepared data form.

Study population

This study was conducted among patients who presented for clinically indicated MRI. All patients referred for MRI for LBP at the 2 centers, irrespective of their age and gender during the study period were included in this study.

Design

This was a retrospective study of all patients who were referred for clinically indicated MRI for LBP. Ethical approval was sought and secured from the Institutional Ethical review board. Consent was not sought from the patients as secondary data and MRI images, and the data were accessed. However, there is compliance with the International Privacy of Individually Identifiable Health Information rules of the Health Insurance Portability and Accountability Act (HIPAA) with strict confidentiality preserved by assigning numbers to each eligible patient in place of real names. Acquisition of Lumbosacral spine images was done by Siemens Magneto concerto open low field 0.2T and 0.3 T, Mindray MRI units and body spine surface coil for imaging the lumbosacral spine at University College Hospital, Ibadan (UCH). A low field open MRI, field strength 0.35 T, General electric units with body spine surface coil was used at Harmony diagnostic center, Ilorin. The subjects

were scanned in supine position and lower legs supported. Standards sequences used after the localizer images were two imaging sequences (T1-weighted [T1-W] and T2-W) in sagittal and axial planes, and as well as postgadolinium scans in appropriate cases. Slice thickness for sagittal sequences was 4 mm and 2–3 mm for axial sequences.

The documented intervertebral disc findings include the following: disc dehydration, disc narrowing, anterior disc herniation, disc bulge, disc protrusion, disc extrusion, sequestered disc, and disc migration.

A prepared data form was utilized to collect the extracted information. The collected data was entered into the Statistical Package for Social Sciences (SPSS) software (Version 20.0., IBM Corp. Released 2011, IBM SPSS Statistics for Windows, IBM Corp. Armonk, NY, USA) spread sheet and analyzed. The data are presented using frequency tables and percentages as appropriate. Chi-square tests were used for statistical analysis of categorical variables.

Results

A total of 205 subjects who were referred for lumbosacral spine MRI for LBP at the two centers were recruited into the study population. Out of which, 198 (96.6%) subjects had most of their documentation complete. The age range of the participant was between 10 and 83 years. Median and mean age were 53 and 52.5 years (± 15.38), respectively. The proportion of females (51.0%) was slightly more than the male subjects (49.0%) with a male to female ratio (male: female) of 1:1.04. Most of the study population (74.7%) were above the age of 40 years, with the largest proportion (29.3%) within the 51–60 years age range, followed by those (18.7%) in the 61–70 years age group. Those in 21–30 years and 31–40 years age groups accounted for 15.7% each while those aged 20 and below constituted only 3.0% [Table 1].

Table 1: Demographic characteristics of study population

	Frequency (n)	Percentage
Age group		
<20 years	6	3.0
21-30	13	6.6
31-40	31	15.7
41-50	31	15.7
51-60	58	29.3
61-70	37	18.7
71 and above	22	11.1
Total	198	100.0
Sex		
Male	99	49.0
Female	103	51.0
Total	202	100

Clinical diagnosis of subjects

All patients referred for MRI had LBP. However, clinical diagnosis of causes of LBP from referring physicians varied [Figure 1]. Lumbar spondylosis was the leading clinical diagnosis. Spondylosis in association with spinal canal stenosis and disc prolapse accounted for 49.2%, while spondylosis alone was seen in 16.1% among the LBP patients. Disc prolapse and epidural compression alone were each seen in 5.8% of the subjects. Spinal canal stenosis was documented in 5.4% of the patients. Spinal tumors were the least clinically suspected diagnosis. Other clinical diagnosis was as listed in Figure 1.

Lumbosacral intervertebral disc changes on magnetic resonance imaging

MRI of the lumbosacral spine in the study population showed that disc bulge (82.8%) was the most frequent disc pathology, followed by disc dehydration in 72.9% and disc protrusion in 60.4%. Anterior disc herniation was noted in 34.3%, disc extrusion was noted in 21% cases, and disc narrowing seen in 17.8%. Disc sequestration was seen in seven cases, four of the cases occur at the sixth decade. Disc migration was recorded in only one case among the study population [Table 2]. Multi-level disc pathologies and multiple degrees of disc herniation were noted in the same patient, and these were frequently seen in many patients [Figure 2].

Test of association using the Chi-square test between disc changes on MRI as the dependent variable and age, gender, and presenting symptoms, and LBP as independent variable were done on the data. The tests shows that there is statistically significant increasing disc changes on MRI with advancing age ($P = 0.01$). Disc changes in relation to gender showed that 42.4% and 48.5% of males and females, respectively, had disc changes on MRI. No statistically significant disc changes were noted in relation to patient's gender ($P = 0.23$). Among patients with lumbar spondylosis, 78.8% had abnormal disc changes on MRI of the lumbosacral spine, and this was statistically significant ($P < 0.001$). In those without lumbar spondylosis, 92 out of the total 120 patients had no disc change on MRI

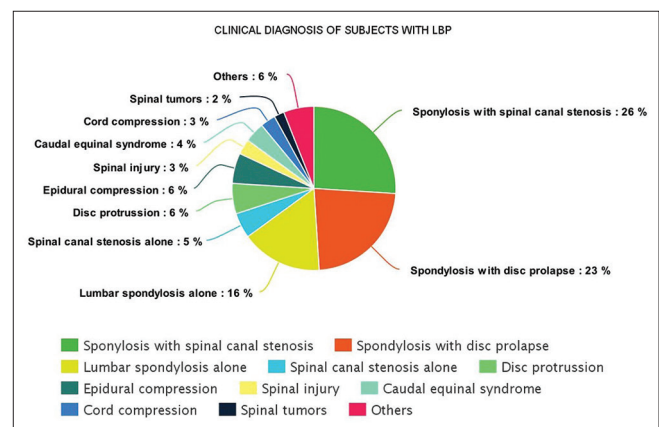


Figure 1: Bar chart showing clinical diagnosis from referring physicians of subjects with low back pain

examination ($P < 0.001$). Nine out of the 12 patients with epidural compression and all the eight patients with caudal equinal syndrome had statistically significant disc changes on MRI examination. $P = 0.01$ and $P = 0.002$, respectively. However, there were no statistically significant MRI abnormal disc findings noted as regard spinal injury as a clinical diagnosis among the study population. Four out of the seven clinically diagnosed spinal cord compression had disc changes on MRI. This was not statistically significant (0.706) as shown in Table 3. Intervertebral disc changes in spinal tuberculosis (TB), in association with other features of TB [Figure 3] were also seen in four cases among other MRI findings in this study.

The LBP patients were categorized into two broad groups according to their clinical symptoms on their request cards. Those with and those without clinical diagnosis of lumbar spondylosis. And correlation with the presence of documented MRI disc changes done. About 78.8% of those with lumbar spondylosis have disc changes on MRI $P = 0.000$. While only 23.3% of those without lumbar spondylosis had disc changes on MRI ($P = 0.000$). The diagnosis of lumbar spondylosis has strong association with the presence of intervertebral disc MRI changes. Conversely, the absence of spondylotic symptoms is also

Table 2: Patient clinico-demographic and disc changes on magnetic resonance imaging among the study population

Patients' characteristic	Disc changes on magnetic resonance imaging n (N)							
	Dehydration	Narrowing	Anterior herniation	Bulge	Protrusion	Extrusion	Sequestration	Migration
Age group (years)								
20 and below	0 (4)	0 (5)	0 (4)	1 (6)	0 (6)	0 (5)	0 (4)	0 (4)
21-30	1 (8)	1 (13)	0 (8)	7 (13)	2 (13)	1 (8)	0 (8)	0 (8)
31-40	9 (20)	2 (31)	5 (20)	24 (31)	14 (31)	4 (22)	1 (20)	1 (20)
41-50	13 (16)	2 (31)	3 (15)	30 (31)	17 (31)	2 (17)	0 (16)	0 (16)
51-60	23 (26)	12 (58)	10 (26)	54 (58)	42 (58)	4 (30)	2 (26)	0 (26)
61-70	25 (26)	7 (37)	13 (26)	31 (37)	30 (37)	9 (26)	4 (26)	0 (26)
>71	7 (7)	11 (52)	5 (7)	17 (22)	15 (22)	4 (7)	0 (7)	0 (7)
Total (%)	72.9 (78/107)	17.8 (35/197)	34.3 (36/106)	82.8 (164/19)	60.4 (119/198)	21.0 (24/115)	6.5 (7/107)	0.9 (1/107)
P value	0.000*	0.001*	0.015*	0.000*	0.000*	0.058	0.433	0.624

NB: Total was calculated based on the actual number of patients that were evaluated on these MRI features. MRI: Magnetic resonance imaging. * Significant P value is <0.05

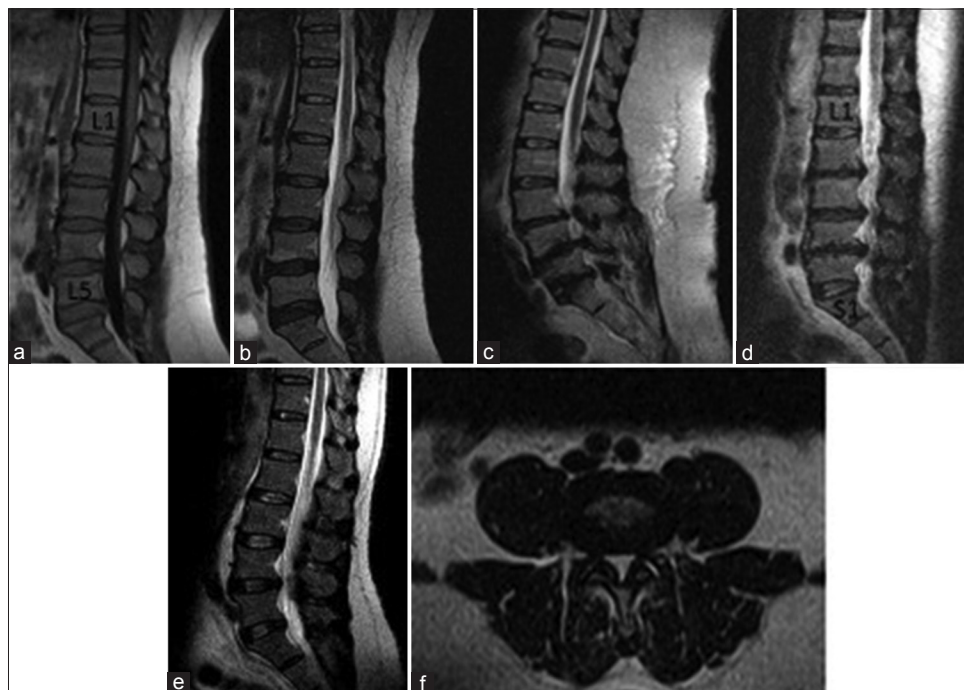


Figure 2: Spectrum of magnetic resonance imaging disc abnormalities. (a and b) T1-weighted mid sagittal image disco-vertebral complex shows L4/5 anterior disc herniation and reduction in height. Posterior disc bulge at L2/3, L5/S1, but no canal stenosis. Dehydration of L3/4-L5/S1 discs noted (b). (c and d) (Sagittal T2-weighted), in addition to above there is L2/3-L5/S1 discs multi-level disc posterior herniation (e), effacement of the anterior theca and spinal canal stenosis at these levels. (f) Show narrowing of exit foraminae bilaterally at L4/5 on T2-weighted axial image

Table 3: Association between magnetic resonance imaging disc changes, patients' age, gender and the Top 7 clinical diagnosis

Patients parameters	Disc changes			χ^2	P
	Present (%)	Absent (%)	Total (%)		
Age group					
20 years and below	2 (33.3)	4 (66.6)	6 (100.0)	16.71	0.01
21-30	4 (30.8)	9 (69.2)	13 (100.0)		
31-40	10 (32.3)	21 (67.7)	31 (100.0)		
41-50	14 (45.2)	17 (54.8)	31 (100.0)		
51-60	34 (69.0)	24 (31.0)	58 (100.0)		
61-70	12 (32.4)	25 (67.6)	27 (100.0)		
71 and above	16 (72.7)	6 (27.3)	22 (100.0)		
Sex					
Male	42 (42.4)	57 (57.6)	99 (100.0)	0.383	0.232
Female	50 (48.5)	53 (51.5)	103 (100.0)		
Lumbar Spondylosis					
Present	67 (78.8)	18 (21.2)	85 (100.0)	62.83	0.000
Absent	27 (22.7)	92 (77.3)	119 (100.0)		
Spinal canal stenosis					
Present	52 (81.2)	12 (18.8)	64 (100.0)	45.60	0.000
Absent	43 (30.5)	98 (69.5)	141 (100.0)		
Disc prolapse					
Present	50 (83.3)	10 (16.7)	60 (100.0)	47.07	0.000
Absent	45 (31.2)	99 (68.8)	144 (100.0)		
Epidural compression					
Present	9 (75.0)	3 (25.0)	12 (100.0)	4.21	0.010
Absent	86 (44.6)	107 (55.4)	193 (100.0)		
Spinal injury					
Present	1 (16.7)	5 (83.3)	6 (100.0)	2.189	0.219
Absent	94 (47.2)	105 (52.8)	199 (100.0)		
Caudal equina syndrome					
Present	8 (100.0)	0 (0.0)	8 (100.0)	9.581	0.002
Absent	85 (43.6)	110 (56.4)	195 (100.0)		
Cord compression					
Present	4 (57.1)	3 (42.9)	7 (100.0)	0.340	0.706
Absent	91 (46.0)	107 (54.0)	198 (100.0)		

Table 4: Pearson's Chi square of disc changes on magnetic resonance imaging and lumbar spondylosis

Patients' category	Disc changes on magnetic resonance imaging			P
	Present	Absent	Total	
Lumbar spondylosis	67 (78.8)	18 (21.2)	85 (100)	0.000
No lumbar spondylosis	28 (23.3)	92 (76.7)	120 (100)	0.000

significantly associated with a very low yield of MRI disc changes [Table 4].

Discussion

LBP affects men and women equally, with onset most often between the ages of 30 and 50 years.^[1] It can however begin in childhood and during early teenage years.^[16,18,19] It is a serious and frequent cause of work-related disability in

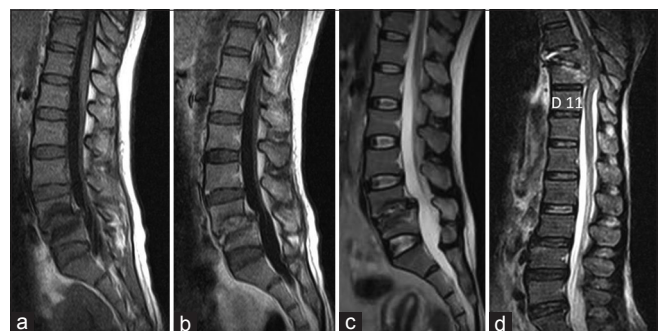


Figure 3: Magnetic resonance imaging sagittal images of lumbosacral (a-c) and thoracolumbar spine (d). These show hypointense to isointense L4/5 disc (a) and moderate enhancement postgadolinium (b) on T1-weighted images and mixed intensity on T2-weighted image; destruction of the adjacent endplates, reduction in height and mild enhancement of the hypointense L4 and L5. All indicating pyogenic discitis and adjacent osteomyelitis. (d) T2-weighted image of another patient, showing anterior wedge collapse of D9 and gibbus, paravertebral and epidural isointense collection and thoracic cord compression from tuberculosis

people under 45 years of age and the most expensive causes of work-related disability in term of workers' compensation and medical expenses.^[1,3]

In this study, LBP showed a marginally higher female preponderance with a male to female ratio of 1:1.1, in tandem with previously documented literature from other parts of the World.^[1] And in agreement with the recent study by Omoke and Amaraegbulam^[24] in Nigeria. This finding is almost in agreement with a higher female preponderance of male: female of 1:2 documented by Galukande *et al.*^[25-27] It is however at variance with the work of Irurhe *et al.*^[21] in Nigeria and Uduma *et al.* in Cameroon^[26] that documented higher prevalence in males. This difference we presume may be due to more males being able to afford the high cost of MRI examination in those centers. In this study, LBP was seen among children and young adult, similar observation was made by Taiamela *et al.* in Finland and Kjaer *et al.*^[9,19]

Most of the cases of LBP among our population occurred commonly between the ages of 51–60 years, in agreement with the work of Uduma *et al.*^[26] The second common age group with LBP was in the 61–70 years. Our finding is however at variance with the work of Andersson that quoted 30–50 years as the peak age for LBP.^[1] It is possible that the occupation of the subjects in our environment may be a factor, as younger population engage in white collar jobs, whereas many of our elderly are artisans and farmers. The mean age of our studied population was 52.5 years in agreement with previous work in Nigeria by Irurhe *et al.*^[21] The LBP patients studied at the two centers were mostly referred for MRI imaging for clinical diagnosis of lumbar/lumbosacral spondylosis alone or in association with spinal canal stenosis or disc prolapse. This is followed by the clinical diagnosis of disc prolapse, epidural compression, and spinal canal stenosis, in decreasing order. Referral for spinal tumors (primary and metastases) accounted for 1.5% almost in agreement but slightly more than the 1% referral for metastases documented by Deyo and Weinstein^[3] but at variance with the 8% documented for neoplasm in Kenya by Orege *et al.* in 2013.^[27] This difference was probably due to the inclusion of patients with preexisting conditions and LBP in the work of Orege *et al.*^[27]

MRI is the modality of choice for the evaluation of the intervertebral discs of LBP when compared with other conventional imaging.^[28] MRI allows for direct evaluation of the internal morphology of the disc. Decrease in water content (dehydration) in disc degeneration, results in decreased signal intensity of the nucleus pulposus on T2-W images.^[29] It is recognized as an accurate tool for detecting intervertebral disc herniation with high accuracy in differentiating the subtypes of disc herniation.^[30] The subtypes include disc bulge, disc protrusion, and disc extrusion.

Disc bulge presents as circumferentially symmetric extension of the disc beyond the adjacent vertebral body while confined by the outermost annulus fibrous fibers. Disc protrusion

occurs when there is a focal or asymmetric extension of the disc beyond the adjacent vertebral body. Disc extrusion is a more extensive extension of the disc (through all layers of the annulus) beyond the interspace. Extruded nucleus pulposus is commonly associated with nerve root compression. Sequestered disc however presents with a fragment that is no longer in continuity with the parent disc material.^[30]

In this study, intervertebral disc changes on MRI varied among the subjects with multiple disc abnormality commonly seen. Disc bulge was the most common disc abnormality in about 82.8%. Disc dehydration accounted for 72.9%, while disc protrusion was seen in 60.4%. Extruded disc, disc height reduction, disc sequestration, and disc migration was seen in 21.1%, 17.8%, 6.5%, and 0.9%, respectively. This is in agreement with the work of Uduma *et al.* in Cameroon^[26-28] and Orege *et al.* among Kenyans^[27] in which disc bulge was the most common disc abnormality. This is contrary to the findings of Irurhe *et al.* that documented disc dehydration as the most common findings (66%), disc height reduction (62%), posterior protrusion (44.7%), posterior extrusion (24.7%), and disc bulge (3.5%).^[21]

In this study, disc herniation was found to be lower in younger age group as documented also by Rehman *et al.*^[31] This in line with the fact that disc herniation increases with increasing age.^[32,33] We also found an association between the age of the studied population and disc abnormalities seen on MRI, in agreement with the works of other researchers.^[32,33]

Multilevel intervertebral disc abnormalities were commonly seen on MRI imaging of the lumbosacral spine in patients with LBP in this study.

Conclusion

This study conducted in the South-Western and North-central geographic zones have shown that no statistically significant gender preponderance exists among Nigerian that presented with LBP. Most cases of LBP occurred in the 51–60 years age group. LBP is also present but uncommon in younger age group. On MRI, disc bulge was the most common disc abnormality seen in about 82.8%. Also increasing MRI disc abnormalities were noted as subjects gets older.

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Conflicts of interest

There are no conflicts of interest.

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