Salud, Ciencia y Tecnología - Serie de Conferencias. 2024; 3:692
doi: 10.56294/sctconf2024692

Category: Health Sciences and Medicine

ORIGINAL

Magnetic resonance imaging assessment of the patterns and distributions of spinal disc degeneration in patients residing in Lagos State

Evaluación por resonancia magnética de los patrones y la distribución de la degeneración discal espinal en pacientes residentes en el estado de Lagos

Ndianekwute Nkiruka Anne[1], Joseph C. Eze[1], Michael Promise Ogolodom[2] ✉

[1]Department of Radiography and Radiological Sciences, Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria.
[2]Department of Radiography, Faculty of Basic Medical Sciences, Rivers State University, Port Harcourt, Nigeria.

Cite as: Ndianekwute N.A, Eze J.C, Ogolodom M.P. Magnetic resonance imaging assessment of the patterns and distributions of spinal disc degeneration in patients residing in Lagos State. Salud, Ciencia y Tecnología - Serie de Conferencias. 2024; 3:692. https://doi.org/10.56294/sctconf2024692

Submitted: 04-12-2023 **Revised:** 19-02-2024 **Accepted:** 30-03-2024 **Published:** 31-03-2024

Editor: Dr. William Castillo-González

ABSTRACT

Background: Degenerative disc disease is a condition in which intervertebral discs losses its structure thereby resulting in loss of cushioning, fragmentation and herniation most times related to ageing. Structural defects and failure are common causes of degenerative disc disease. In some cases, the spine loses flexibility and bone spurs may pinch a nerve root, causing pain or weakness. The aim of this study was to assess the prevalence and distribution of disc degeneration over the spines in patients residing in Lagos state using magnetic resonance imaging.
Materials and methods: This was a cross-sectional prospective study conducted among 163 patients presented for spinal magnetic resonance imaging (MRI) scan due to disc degeneration in some selected radio-diagnostic centres in Lagos State, Nigeria. The spine structural appearance, intervertebral disc structural appearance, signal intensity, pathologies, gender, age, height, weight and BMI of the patients will be recorded. Both descriptive (mean, percentage, charts and frequency) and inferential statistics (Chi-square) statistics were used for statistical analysis with p-value set at 0,05.
Results: Out of 163, 96(58,9 %) were female while males were 67(41,1 %). The age of the study population ranges from 20 years to 90 years with a mean age of 57,17 ± 12,35. Grade V was highest 64 (39,3 %) followed by 32 (25,8 %) grade IV and least 10 (6,1 %) were grade II. The study found the most common affected on L_4/L_5 disc with 35 (21,5 %) adults demonstrating disc degeneration, while 17 (10,4 %) adults demonstrated no disc degeneration. There is no statistically significant association between gender and pattern of disc degeneration (x^2 = 5,943, p =0,203).
Conclusion: The majority of the patients had the grade V patterns of degenerated discs based Pffirman grading system. The most affected disc was the L4/L5 disc followed by the L3/L4 disc. There were negative correlations but not statistically significant between weight and BMI respectively and patterns of the disc degeneration diseases. There exist positive correlations but not statistically significant between age and height respectively, and patterns of the disc degeneration diseases. There is no statistically significant association between gender and pattern of disc degeneration.

Keywords: Disc Degenerative Disease; Lower Back Pain; MRI.

RESUMEN

Antecedentes: la enfermedad degenerativa discal es una afección en la que los discos intervertebrales

pierden su estructura, lo que provoca pérdida de amortiguación, fragmentación y hernia, la mayoría de las veces relacionadas con el envejecimiento. Los defectos y fallos estructurales son causas frecuentes de la enfermedad degenerativa discal. En algunos casos, la columna pierde flexibilidad y los espolones óseos pueden pinzar una raíz nerviosa, causando dolor o debilidad. El objetivo de este estudio era evaluar la prevalencia y la distribución de la degeneración discal en la columna vertebral de pacientes residentes en el estado de Lagos mediante resonancia magnética.

Materiales y métodos: Se trató de un estudio prospectivo transversal realizado entre 163 pacientes que se presentaron para someterse a una resonancia magnética (RM) de la columna vertebral debido a una degeneración discal en algunos centros de radiodiagnóstico seleccionados del estado de Lagos, Nigeria. Se registrarán el aspecto estructural de la columna vertebral, el aspecto estructural del disco intervertebral, la intensidad de la señal, las patologías, el sexo, la edad, la altura, el peso y el IMC de los pacientes. Para el análisis estadístico se utilizaron estadísticas tanto descriptivas (media, porcentaje, gráficos y frecuencia) como inferenciales (Chi-cuadrado), con un valor p fijado en 0,05.

Resultados: De los 163 participantes, 96 (58,9 %) eran mujeres y 67 (41,1 %) hombres. La edad de la población estudiada oscilaba entre los 20 y los 90 años, con una media de 57,17 ± 12,35 años. El grado V fue el más elevado con 64 (39,3 %), seguido de 32 (25,8 %) de grado IV y el menos frecuente con 10 (6,1 %) de grado II. El estudio halló la afectación más común en el disco L4/L5 con 35 (21,5 %) adultos que mostraban degeneración discal, mientras que 17 (10,4 %) adultos no mostraban degeneración discal. No hay asociación estadísticamente significativa entre el género y el patrón de degeneración discal (x2 = 5,943, p =0,203).

Conclusiones: La mayoría de los pacientes tenían los patrones de grado V de los discos degenerados basado Pffirman sistema de clasificación. El disco más afectado fue el L4/L5, seguido del L3/L4. Existían correlaciones negativas pero no estadísticamente significativas entre el peso y el IMC respectivamente y los patrones de las enfermedades de degeneración discal. Existen correlaciones positivas, pero no estadísticamente significativas, entre la edad y la estatura, respectivamente, y los patrones de las enfermedades de degeneración discal. No existe asociación estadísticamente significativa entre el sexo y el patrón de degeneración discal.

Palabras clave: Enfermedad Degenerativa Discal; Lumbalgia; IRM.

INTRODUCTION

Magnetic resonance imaging (MRI) is a non-invasive procedure and the most important method for clinical assessment of intervertebral disc pathology.[1] Modic 1 signal changes detected on magnetic resonance imaging (MRI) encompass clinical, radiological and biological features, which allows for defining a specific subgroup of patients with chronic low back pain (cLBP). Elementary MRI and histopathological alterations involving intervertebral disc (IVD) and vertebral endplate subchondral bone (VESB) associated with Modic 1 changes, were first described and classified by Modic et al., in the late 1980s.[2]

Briefly, Modic 1 changes are characterized by VESB decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images, whereas Modic 2 changes show VESB increased signal intensity on T1-weighted images and isointense or slightly increased signal intensity on T2-weighted images. Along with VESB changes, changes in IVD related to degenerative disc disease (DDD) also occur, and include intervertebral space narrowing (IVSN) and disc herniation.

In Modic et al.[3] study, Modic 1 VESB changes were consistently associated with DDD features. Correlation with the grade of DDD was not assessed. Li-Peng et al.[4] recently reported that Modic changes were correlated with Pfirrmann grades of lumbar DDD. These grades were significantly higher with Modic 1 than Modic 0 or 2 changes.[5] Early detection of degenerated disc is very helpful to prevent further deterioration, hence the need for a safer modality to detect early changes in patients suffering from this disease. Furthermore, Magnetic resonance imaging is not enlisted as a routine when patients present early symptoms.

The incidence of degenerative intervertebral disc disease is raising exponentially,[6] hence the need for improved management scheme for patients suffering from this disease. Early detection can prevent further deterioration since management would have commenced early enough to prevent further complications. To the best of researcher's knowledge, a little has been done therefore the need to build and create a resourceful awareness in the benefits of the use of magnetic resonance imaging as compared to other modalities in early detection through careful observation of its patterns and presentation. This study was designed to assess the patterns and distributions of the disc degenerations on MRI among patients in Lagos State, Nigeria.

MATERIALS AND METHODS

A prospective cross-sectional study was carried out among 163 patients who underwent spinal MRI investigations due to disc degeneration in some selected radio-diagnostic centres in Lagos Nigeria. Only patients

who passed the contraindication screening and were referred for MRI due disc degeneration and consented to this study were included in this study. Patients with intervertebral disc degenerative disease who were not willing to participate or are uncooperative with the examination were excluded from the study. An approval for this study was obtained from the Research Review Boards of the various selected centres. The participants consent was duly sought using written informed consent.

Instrument/method of data collection

Data were collected by performing magnetic resonance imaging of the spine using a GE 1,5T MRI scanner for patients with disc degenerative disease. The spine structural appearance, intervertebral disc structural appearance, signal intensity, pathologies, gender, age, height, weight and BMI of the patients were recorded. Weight was measured on a calibrated portable bathroom scale. Height and weight measuring scale (Surgifriend Medicals England) was used for patients, with the participants standing upright in the normal anatomical position. Clinical data of patients with degenerative lumbar disc disease and also with disc protrusion, spinal stenosis, spondylolisthesis, and low back pain were examined.

The magnetic resonance imaging examinations were performed with the patients in the supine position for optimal visualization of the spines and intervertebral disc also for the patient's comfortability. Spinal alignment and osseous structures were assessed if there is straightening of the normal lumbar curvature. The vertebral alignments are assessed if preserved. The heights of all the vertebral bodies are assessed if preserved, also if all the intervertebral discs are normal in height with preserved hydration status or not. Then the scan was taken using different protocols necessary for each spinal examination. Then level by level analysis was done to note any disc bulge or herniation, spinal canal compression or foraminal narrowing. Also diffuse annular disc bulge, bilateral ligamentum flavum and facet joint hypertrophy, narrowing of both neural foramina; with resultant nerve root compression were assessed. The spinal canal and thecal sac is assessed. MR myelography is essential.

Patients were examined using sagittal T1- and T2-weighted MR imaging sequences. Patients undergone fast spin-echo sagittal T1 and T2-weighted imaging and cross-sectional T2-weighted scanning (repetition time msec/echo time msec, 3400/114; 32-cm field of view; four signals acquired; 4-mm contiguous section thickness and interslice gap 1 mm, NEX 3, variable bandwidth 31,2 kHz, and a maximum of 13 scan planes). Scanning software was used with the option of no phase wrap, variable bandwidth and no frequency wrap. Modic changes were graded as previously described by Li-Peng et al.[4]

Also the Pfirrmann grading system was used to assessed structural distinction of the nucleus pulposus and the annulus fibrosus, signal intensity of intervertebral discs and height of intervertebral discs and assigns grade I to V for disc degeneration and the modified Pfirrmann grading system which assigns grade 1 to 8 for disc was used to assessed degenerated intervertebral disc by evaluating signal intensity of the nucleus pulposus and the inner annulus, signal intensity difference between the inner and outer part of the posterior annulus and height of intervertebral discs. All of this was achieved using the consultant radiologist reports in charge of the patient and the obtained data were captured on a spread sheet designed for data collation.

Data analysis

Data collected were analysed using statistical package for social Sciences (SPSS) version 20.0 and descriptive (frequency, percentage, bar charts and tables) and inferential (Chi-square and correlation) were the statistical tools used for statistical analysis with level of statistical significance set at $p < 0,05$.

RESULTS

Out of 163 participants, the majority 96 (58,9 %) were female while the males accounted for 67 (41,1 %) (figure 1).

The majority 47 (28,8 %) were within the age group of 61-70 years and the least 1 (0,6 %) were within the age group < 31 years. The age of the study population ranges from 20 years to 90 years with a mean age of 57,17 ± 12,35 (table 1).

The weight of the study population ranges from 40kg to 100kg with a mean weight of 81,57 ± 11,63. The height of the study population ranges from 1,2m to 2,0m with a mean height of 1,64 ± 0,15. The Body Mass Index (BMI) of the study population ranges from 13,8kg/m^2 to 51,0kg/m^2 with a mean BMI of 31,34 ± 7,40 (table 2).

The MRI findings on the degenerated discs demonstrates that sixty-four (39,3 %) of the patients can be classified on the Grade V of the Pffirman grading system. Forty-two (25,8 %) were classified on grade IV. Thirty-one (19,0 %) were classified on grade three. Sixteen (9,8 %) were classified on grade I and ten (6,1 %) were classified on grade II (figure 2).

Among the patients, the most affected disc was the L4/L5 disc with 35(21,5 %) subjects demonstrating disc degeneration in this disc alone. The second most affected disc was the L3/L4 disc with 20(12,3 %) of patients demonstrating disc degeneration in this disc alone. In addition to these 17(10,4 %) subjects demonstrated no

https://doi.org/10.56294/sctconf2024692

disc degeneration (table 3).

There were negative correlations but not statistically significant between weight (r=-0,059, p=0,453) and BMI (r=-0,065, p= 0,407) respectively and patterns of the disc degeneration diseases. There exist positive correlations but not statistically significant between age (r=0,151, p= 0,055) and height (r= 0,016, p= 0,837) respectively, and patterns of the disc degeneration diseases (table 4).

There is no statistically significant association between gender and pattern of disc degeneration (x^2 = 5,943, *p* >0,05). Out of the 64 samples which were classified under grade V using the Pffirrman grading system, 41 (64,1 %) were female while 23 (35,9 %) were male. Out of the 42 samples which were classified under grade IV using the Pffirrman grading system, 21 (50 %) were female while 21 (50 %) were male (table 5).

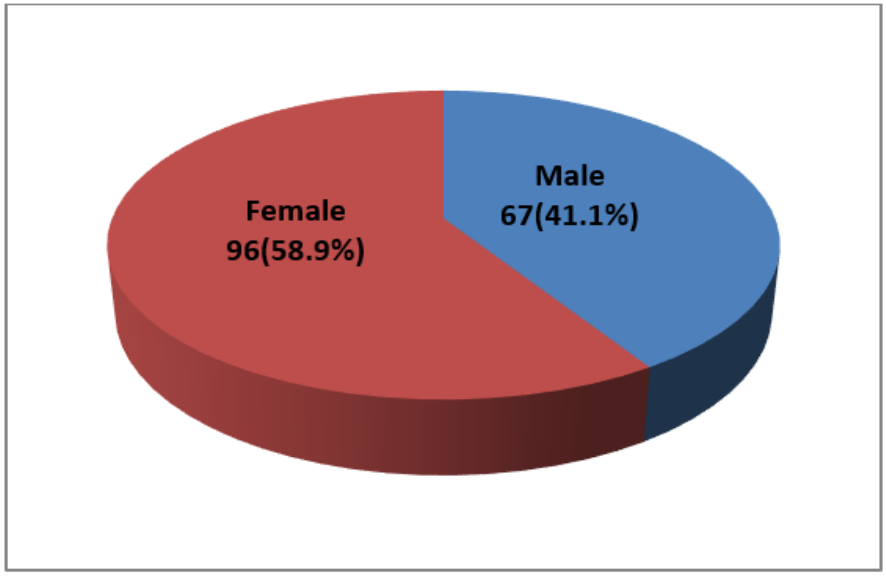

Figure 1. Gender distribution of subjects

Table 1. Frequency of age distribution of the participants

Age (Years)	Frequency (n)	Percentage (%)
< 31	1	0,6
31 - 40	16	9,8
41 - 50	36	22,1
51 - 60	46	28,2
61 - 70	47	28,8
71 - 80	13	8,0
81 - 90	4	2,5
Total	163	100
Mean age = 57,17 ± 12,35		

Table 2. Physical characteristics of subjects

Variables	Frequency (n)	Percentage (%)
Weight (kilograms)		
< 61	6	3,7
61 - 70	28	17,2
71 - 80	53	32,5
81 - 90	45	27,6
91 - 100	31	19,0
Total	163	100
Mean weight: 81,57 ± 11,63		

https://doi.org/10.56294/sctconf2024692

Height (metres)		
< 1,31	5	3,1
1,31 - 1,50	49	30,1
1,51 - 1,70	65	39,9
1,71 - 1,90	43	26,4
.> 1,90	1	0,6
Total	163	100
Mean height: 1,64 ± 0,15		
Body Mass Index (kg/m^2)		
Underweight (< 18,50)	5	3,1
Normal weight (18,50 - 24,90)	28	17,2
Overweight (25,00 - 29,90)	44	27,0
Obese (> 29,90)	86	52,8
Total	163	100
Mean body mass index: 31,34 ± 7,40		

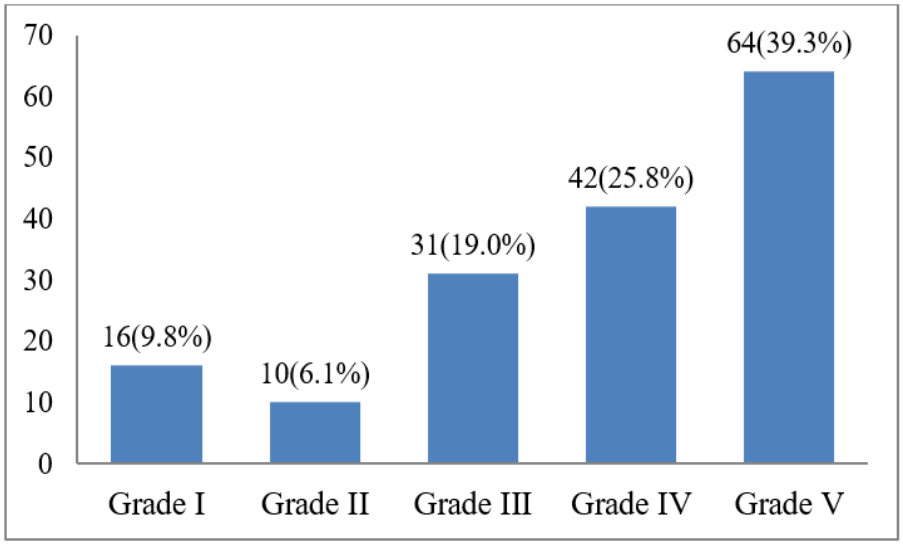

Figure 2. Pattern of disc degeneration among patients using Pffirrman grading system

Table 3. Distribution of disc involvement among subjects

Disc	Frequency (n)	Percentage (%)
L4/L5	35	21,5
L3/L4	20	12,3
NIL	17	10,4
L4/L5-L5/S1	15	9,2
L3/L4-L5/S1	11	6,7
C3/C4-C5/C6	7	4,3
C5/C6	5	3,1
L3/L4-L4/L5	5	3,1
L5/S1	5	3,1
C3/C4	4	2,5
L2/L3	4	2,5
T11/T12	4	2,5
C2/C3-C6/C7	3	1,8
C4/C5-C6/C7	3	1,8
C2/C3 & C7/T1	2	1,2

https://doi.org/10.56294/sctconf2024692

C2/C3-C4/C5 & T4/T5-T7/T8	2	1,2
C3/C4-C6/C7	2	1,2
C3/C7-C7/T1	2	1,2
L2/L3 & L5/S1	2	1,2
L2/L3-L5/S1	2	1,2
C3/C4 7 L2/L3-L4/L5	1	0,6
C3/C4-C4/C5	1	0,6
C4/C5-C5/C6 & C7/T1	1	0,6
C4/C5-C7/T1	1	0,6
C5/C6-C6/C7	1	0,6
C5/C6-C7/T1	1	0,6
C6-C7	1	0,6
C6/C7	1	0,6
L1/L2	1	0,6
L2/L3 & L4/L5	1	0,6
T12/L1	1	0,6
T6/T7	1	0,6
T8/T9-T11/T12	1	0,6
Total	163	100

Table 4. Correlation anthropometric variables (age, weight, height, BMI) with pattern of disc degeneration in degenerative intervertebral disc patients

Anthropometric variable	Spearman's rho	p-value	Remark
Age	0,151	0,055	Not significant
Weight	-0,059	0,453	Not significant
Height	0,016	0,837	Not significant
BMI	-0,065	0,407	Not significant

Table 5. Association between gender and patterns of disc degeneration

	Female N (%)	Male N (%)	Total N (%)	X^2	P-value
Grade I	8(50,0)	8(50,0)	16(100)	5,943	0,203
Grade II	4(40,0)	6(60,0)	10(100)		
Grade III	22(71,0)	9(29,0)	31(100)		
Grade IV	21(50,0)	21(50,0)	42(100)		
Grade V	41(64,1)	23(35,9)	64(100)		
Total	96(58,9)	67(41,1)	163(100)		

DISCUSSION

Degenerative disc disease is caused by the drying out of the disc as 80 percent of the disc constitutes water. Activities and sport, can cause tears, injuries, swelling, soreness and instability in the outer core of the disc. Spinal disc wear down is a normal part of aging, when the spinal disc dries out.

Lumbar disc degeneration is the most common cause of low back pain. plain radiograph can help in visualising gross anatomic changes in the intervertebral disc. But, MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanar imaging capability, excellent spinal soft - tissue contrast and precise localization of intervertebral disc changes.[7]

In this study, a total of 163 adult patients were scanned 96 (58,9 %) of which were mostly affected were the females and 67 (41,1 %) were males and most of the patients show loss of lumbar lordosis. The mean age affected the most were patients at 57 years approximately (+/- 12years) so it can be said that degenerative disc disease is a condition that affects young to middle aged persons with peak incidence at approximately

57 years from this study location, this is in agreement with previous study.[7] According to Cleveland Clinic[8], degenerative disc disease is most common in older adults. Some factors increase one's risk of developing degenerative disc disease such as acute injuries, obesity, smoking, working a physically demanding job. From the observations from this study, one can deduce that the mean weight, height and body mass index, patients with greater body mass index are more susceptible to the disease condition.

The observational findings from this study demonstrates that sixty-four (39,3 %) of the patients with degenerative disc disease are classified as grade V on the pfirrmann grading system. The discs were found to be inhomogenous and black with loss in distinction of the nucleus polposus and annulus fibrosus and hypointense signal intensity. The heights of the intervertebral disc were found to be collapsed. These findings were prominent at L4-L5. Previous study also recorded L4-L5 disc as the most commonly involved.[7]

Fourthy -two (25,8 %) were classified on grade IV. The features of these degenerative disc disease illustrated inhomogenous structures which appears grey to black with loss in distinction of the nucleus polposus and annulus fibrosus and resultant intermediate to hypointense of signal intensity. These were mostly occurring at disc levels L3-L4. The heights of intervertebral disc appear normal to moderately decreased.

Thirty-one (19,0 %) were classified on grades III. These disc structures are inhomogeneous appearing grey. The nucleus polposus and annulus fibrosis appears unclears with intermediate signal intensity. The intervertebral disc height appears normal to slight decrease in height and occurred majorly at C3-C5.

10 (6,1 %) were classified on grade 1 and 16 (9,8 %) were classified on grade 1. Disc are distributed ranging from inhomogenous with or without horizontal bands to homogenous bright white. The nucleus polposus and annulus fibrosus appear clearly with signal intensity ranging from hyperintense to isointense to cerebrospinal fluid. The intervertebral disc height appears normal mostly occurring at disc levels L1-L2, T12-L1, T6-T7 to T11-T12.

Among the patients affected the most, the prevalent disc affected was at the level of L4-L5 disc with and the second most prevalent disc affected was at disc level L3-L4 disc with patients demonstrating disc degeneration. This means that different levels of the spines were affected at different degrees.

There were negative correlations but not statistically significant between weight and BMI respectively and patterns of the disc degeneration diseases. This imply that the relationships between weight and BMI with patterns of disc degenerative diseases are weak and also, increase in both weight and BMI does not increases the degree of disc degenerative diseases. There exist positive correlations but not statistically significant between age and height respectively, and patterns of the disc degeneration diseases. This imply that the relationships between age and height with patterns of disc degenerative diseases are weak but increase in both age and height increases the degree of disc degenerative diseases.

CONCLUSION

The majority of the patients had the grade V patterns of degenerated discs based Pffirman grading system. The most affected disc was the L4/L5 disc followed by the L3/L4 disc. There were negative correlations but not statistically significant between weight and BMI respectively and patterns of the disc degeneration diseases. There exist positive correlations but not statistically significant between age and height respectively, and patterns of the disc degeneration diseases. There is no statistically significant association between gender and pattern of disc degeneration.

REFERENCES

1. Swartjes A, P. B White, M Lammertink, J. Elemans and R. J. M. Nolte, Host Guest Exchange of Viologen Guests in Porphyrin Cage Compounds as studied by selective Exchange Spectroscopy(1D EXSY) NMR, Angew. Chem., Int. Ed.,2021; 60:1254-1262.

2. Bailly F, Maigne JY, Genevay S, Marty M, Gandjbakhch F, Rozenberg S, et al. Inflammatory pain pattern and pain with lumbar extension associated with Modic 1 changes on MRI: a prospective case–control study of 120 patients. Eur Spine J. 2014;23(3):493–7.

3. Rodríguez JMM, Martínez DV, Arteaga CRE, Vázquez DM, Díaz GFM. Use of Phytopharmaceuticals as an alternative in the treatment of cardiovascular conditions in adults. AG Salud 2024;2:53-53. https://doi.org/10.62486/agsalud202453.

4. Modic MT, Steinberg PM, Ross JS et-al. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology. 1988; 166 (1): 193-9.

5. Li-Peng Y, Wen-Wu Q, Guo-Yong Y, Young-Xin R, Zhi-Yi H.MRI assessment of lumbar intervertebral disc degeneration with lumbar degenerative disease using the Pfirrmann grading systems. PLoS One. 2012; 7(12):

e48074.

6. Kanna RM, Shetty AP, Rajasekaran S. Patterns of lumbar disc degeneration are different in degenerative disc disease and disc prolapse magnetic resonance imaging analysis of 224 patients. Spine J. 2014;14(2):300–7.

7. Pupo-Martínez Y, Dalmau-Ramírez E, Meriño-Collazo L, Céspedes-Proenza I, Cruz-Sánchez A, Blanco-Romero L. Occlusal changes in primary dentition after treatment of dental interferences. AG Odontologia 2023;1:10-10. https://doi.org/10.62486/agodonto202310.

8. Hinojosa BLA, Mendoza OAV, Claudio BAM. Perceptions on the use of Digital Marketing of the micro-entrepreneurs of the textile sector of the Blue Gallery in the emporium of Gamarra. SCT Proceedings in Interdisciplinary Insights and Innovations 2023;1:9-9. https://doi.org/10.56294/piii20239.

9. Hui Cao , Mengyu Dou Zexiang Lyu Yingxiong Wang , Christian Marcus Pedersen, Yan Qiao. Understanding the interaction mechanism of carbazole/anthracene with N,N-dimethylformamide: NMR study substantiated carbazole separation. Inductrial Chemical Matter. 2022, 1, 240-246

10. Suthar P, Patel R, Mehta C, Patel N.MRI evaluation of lumbar disc degenerative disease. J Clin Diagn Res. 2015; 9(4): TCo4-9

11. Usoro I.E, Akhigbe R.O, Ogolodom M.P, Shuaibu A, Ezugwu E.E, Oyegbata O.T, Ron M, Egbeyemi O.O. Patterns of Computed Tomography Imaging Findings in Patients Diagnosed with Cerebrovascular Accident in Nigeria: A Single Center Study. AG Salud. 2024;2:75. https://doi.org/10.62486/agsalud202475

12. Cleveland Clinic. Degenerative Disk Disease. 2015. Available from: https://my.clevelandclinic.org/health/diseases/16912-degenerative-disk-disease?__cf_chl_captcha_tk__=pmd_sfm6yP19Y4NBhzzOZbfLFaox_XKiipiQaR5.EkD05oc-1634111386-0-gqNtZGzNAxCjcnBszQi9.

FINANCING

No financing.

CONFLICT OF INTEREST

None.

AUTHORSHIP CONTRIBUTION

Conceptualization: Ndianekwute Nkiruka Anne, Joseph C. Eze, Michael Promise Ogolodom.
Writing - Original Draft Preparation: Ndianekwute Nkiruka Anne, Joseph C. Eze, Michael Promise Ogolodom.
Writing - Review & Editing: Ndianekwute Nkiruka Anne, Joseph C. Eze, Michael Promise Ogolodom.