⊡ OPEN ACCESS

Original Research Article

Spectrum and Clinical Correlates of MRI Modic Changes in Degenerative Lumbar Spine Disease: A Gender-Disparate Pattern in North Cameroonian Population

Mbozo'o Mvondo S[1]*, Aminou M[1], Boutche Yaouba L[2], Onana YR[1], Tetka Mekou Viang MG[1], Neossi Nguena[2], Mbo AJ[1], Zeh OF[3], Ngaroua[1]

[1]Faculty of Medicine and Biomedical Sciences, University of Garoua
[2]Faculty of Sciences, Université de Ngaoundéré
[3]Faculty of Medicine and Biomedical Sciences, University of Yaoundé 1, Cameroon

Abstract: *Background*: Modic changes (MCs) are magnetic resonance imaging (MRI) signal alterations in the vertebral endplates and adjacent bone marrow, classified into types 1 (inflammatory), 2 (fatty), and 3 (sclerotic). Their prevalence and clinical significance, particularly in sub-Saharan African populations, are not well characterized and may be influenced by local demographic and biomechanical factors. *Objective*: To determine the prevalence, distribution, and demographic associations of Modic changes in patients with symptomatic degenerative lumbar spine disease at the Garoua Regional Hospital, Cameroon. *Methods*: A hospital-based cross-sectional study was conducted. Out of 418 lumbar MRI scans performed between January 2023 and June 2025, 121 patients with degenerative pathology were included. MCs were evaluated on T1- and T2-weighted sagittal images and classified according to the standard Modic system. Associations with age, sex, and occupation were analyzed using Chi-square tests in SPSS 20.0. *Results*: The overall prevalence of MCs in our symptomatic cohort was **48.3% (59/121)**. Modic type 2 was the most common subtype (25.7%), followed by type 1 (16.5%) and type 3 (6.1%). A highly significant gender-specific distribution was observed: Modic type 1 changes were significantly more prevalent in males (25.9% vs. 9.0%; p=0.005), while Modic type 3 changes showed a strong female predominance (11.9% vs. 1.9%; p=0.002). The most affected occupational groups were female traders and housewives. *Conclusion*: This study provides novel data on Modic changes in a West African population. Nearly half of symptomatic patients exhibited MCs, with a clear and significant gender disparity: an inflammatory pattern (Modic 1) associated with males and a sclerotic pattern (Modic 3) associated with females. These findings suggest potentially distinct pathophysiological pathways or risk factor exposures influenced by gender, possibly related to occupational biomechanics and hormonal factors. Recognizing these patterns is crucial for the clinical interpretation of lumbar spine MRI in this demographic context.

Keywords: Modic Changes, Vertebral Endplate, Bone Marrow Edema, Lumbar Spine Degeneration, MRI, Gender Differences, Cameroon.

1. INTRODUCTION

Degenerative lumbar spine disease is a leading cause of disability worldwide, with magnetic resonance imaging (MRI) serving as the principal modality for anatomical assessment [1]. Beyond disc herniation and canal stenosis, MRI reveals subtle alterations in the vertebral bone marrow adjacent to degenerated discs. These alterations, known as Modic changes (MCs), were first systematically classified by Modic *et al.*, in 1988 and have since become a critical component of the radiological lexicon [2].

MCs are categorized into three types based on their signal characteristics on T1- and T2-weighted sequences: Type 1 (hypointense T1, hyperintense T2) represents bone marrow edema and inflammation, often

interpreted as an active or unstable phase; Type 2 (hyperintense T1, iso- or hyperintense T2) indicates fatty replacement of the marrow, considered a more stable, chronic change; and Type 3 (hypointense T1, hypointense T2) reflects subchondral bone sclerosis [2].

The clinical relevance of MCs, particularly Modic type 1, remains a subject of intense research, with studies linking them to the presence and intensity of low back pain [3, 4]. However, their epidemiology is not uniform. Prevalence and type distribution vary across studies and populations, potentially influenced by genetic, biomechanical, and occupational factors [5, 6]. Data from sub-Saharan Africa are conspicuously scarce, leaving a gap in the global understanding of these phenomena.

This study, conducted in northern Cameroon, aimed to address this gap by specifically investigating Modic changes. Our objectives were: 1) to determine the prevalence and type distribution of MCs in a cohort of patients with symptomatic degenerative lumbar disease, and 2) to analyze their associations with key demographic variables, including gender and occupation, in a semi-rural African setting.

2. METHODS
2.1. Study Design and Population:
This cross-sectional analysis is part of a larger study on degenerative lumbar spine pathologies at the Garoua Regional Hospital. We included 121 adult patients (≥18 years) with clinical lumbar pain and MRI-confirmed degenerative disease, selected from a total of 418 consecutive lumbar MRI examinations performed between January 2023 and June 2025. Patients with a history of spinal surgery, trauma, infection, or neoplasm were excluded.

2.2. MRI Protocol and Assessment of Modic Changes:
All examinations were performed on a 0.35 Tesla MAGNETOM C! MRI system (Siemens Healthcare). The standard protocol included sagittal T1-weighted, T2-weighted, and STIR sequences. A senior radiologist, blinded to the clinical details for the retrospective cohort, reviewed all studies. Modic changes were identified in the vertebral body marrow adjacent to degenerated discs. Each affected endplate was classified as:

- **Modic Type 1:** Low signal on T1-weighted images, high signal on T2-weighted images.
- **Modic Type 2:** High signal on T1-weighted images, iso- to high signal on T2-weighted images.
- **Modic Type 3:** Low signal on both T1- and T2-weighted images.

The presence of "No Modic changes" was also recorded. For patients with multiple affected levels, the most cephalad significant change was used for the primary categorical analysis.

2.3. Data Analysis:
Data were entered and analyzed using SPSS version 20.0 (IBM Corp.). Descriptive statistics (frequencies, percentages, mean ± SD) described the cohort and MC prevalence. The Chi-square test (or Fisher's exact test where appropriate) was used to examine associations between Modic type (categorical variable) and independent variables such as sex and age group. A p-value of less than 0.05 was considered statistically significant.

2.4. Ethical Considerations:
The study received ethical approval from the Institutional Review Board of the University of Garoua. Informed consent was obtained from all participants in the prospective phase, and anonymity was maintained for retrospective data.

3. RESULTS
3.1. Population Characteristics:
The mean age of the 121 patients was 55.0 ± 13.6 years. The cohort demonstrated a significant female predominance (55.4%, n=67). The most represented occupational groups were female traders (36.3%) and housewives (16.5%).

3.2. Prevalence and Distribution of Modic Changes:
Modic changes were present in 59 of the 121 patients, yielding an overall prevalence of 48.3%. The distribution among the different types is shown in Figure 1 and Table 1. Modic type 2 was the most frequent subtype, found in 25.7% of the total cohort. This was followed by Modic type 1 (16.5%) and Modic type 3 (6.1%). Slightly more than half of the patients (51.7%) had no detectable Modic changes.

3.3. Association with Gender – A Key Finding:
The analysis revealed a striking and statistically significant association between gender and the type of Modic change (**Table 1**).

- **Modic Type 1** showed a significant male predominance, present in **25.9% of males** compared to only **9.0% of females** (p=0.005). (Figure 2, Figure 3)
- Conversely, **Modic Type 3** was strongly associated with the female sex, identified in **11.9% of females** versus **1.9% of males** (p=0.002). (Figure 2)
- The prevalence of Modic Type 2 was not significantly different between genders (p=0.561). (Figure 4)

Table 1: Prevalence and Gender Distribution of Modic Changes

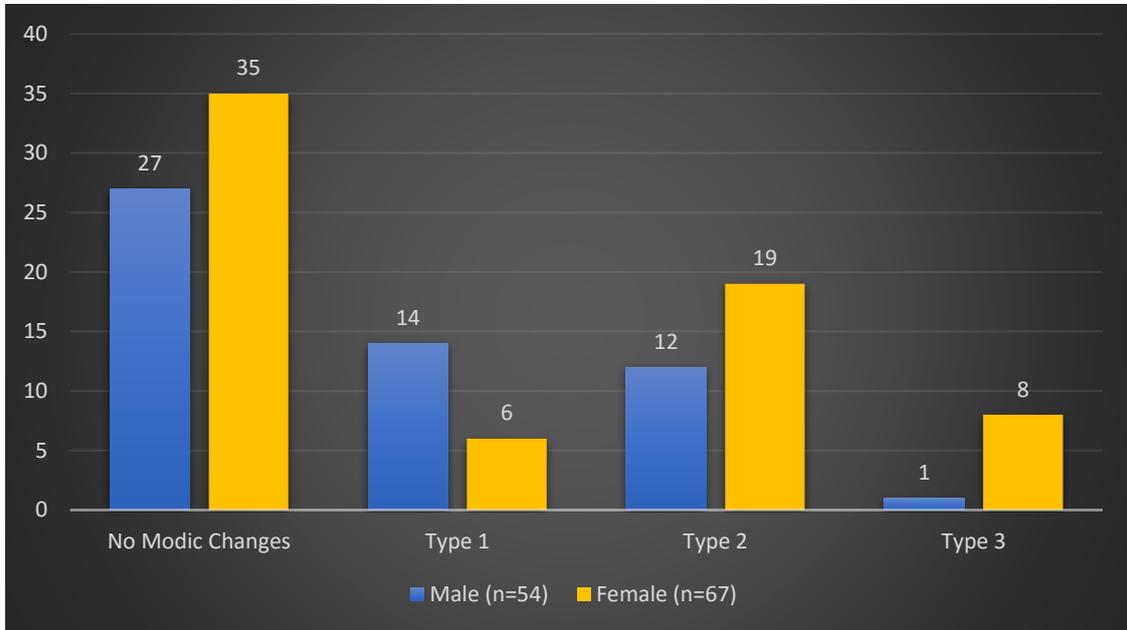| Modic Classification	Total Cohort (n=121)	Male (n=54)	Female (n=67)	p-value (Gender)
No Modic Changes	62 (51.7%)	27 (50.0%)	35 (52.2%)	0.808
Type 1	20 (16.5%)	**14 (25.9%)**	6 (9.0%)	**0.005**
Type 2	31 (25.7%)	12 (22.2%)	19 (26.9%)	0.561
Type 3	9 (6.1%)	1 (1.9%)	**8 (11.9%)**	**0.002**

Figure 1: Distribution of Modic Changes in the Study Cohort (n=121)

Figure 2: T2 and T1 lumbar sagittal mri of a 65 years old female patient with Modic 1 at L2L3 and Modic 3 at L3L4 associated with degenerative changes and disc protrusions
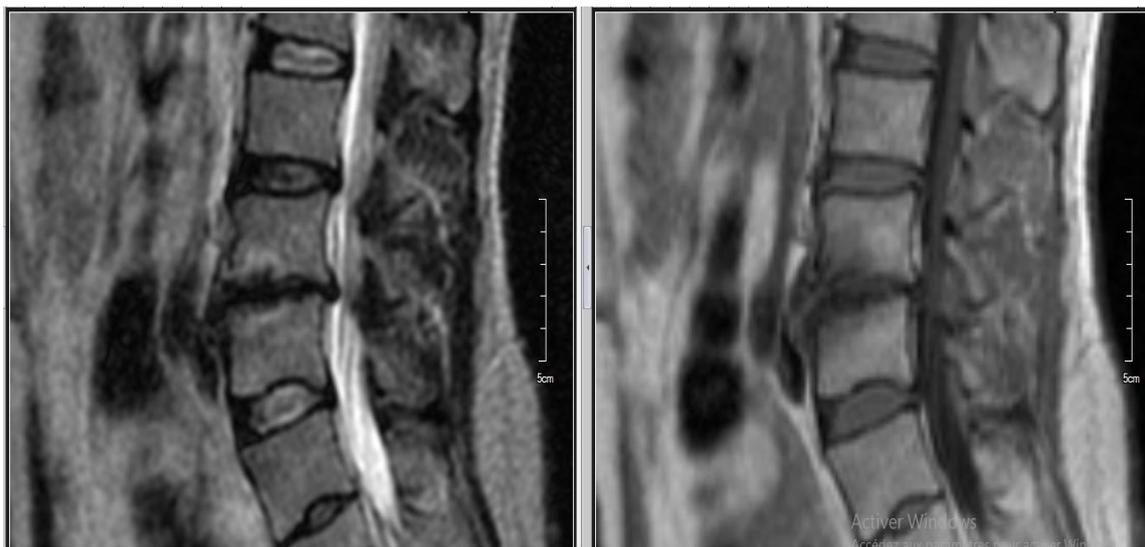
Figure 3: T2 and T1 lumbar sagittal mri of a 47 years old male patient with Modic 1 at L3L4 associated with degenerative spine and disc protrusion

Figure 4: T2 and T1 lumbar sagittal mri of a 52 years old male patient sufferinf of chronic back pain with degenerative spine, spinal straightness, generalised lumbar arthrosis, Modic 2 at L4L5 and disc protrusion at L5S1

3.4. Association with Age and Occupation:

No statistically significant correlation was found between the presence or type of Modic change and specific age groups (p>0.05). However, the occupational distribution highlighted that the majority of patients with MCs (particularly females with Modic 3) belonged to groups engaged in non-mechanized physical labor (traders, housewives).

4. DISCUSSION

This study offers one of the first dedicated analyses of Modic changes in a symptomatic West African population. The overall prevalence of 48.3% aligns with the broad range (20-60%) reported in international studies of symptomatic patients [3-5], confirming that MCs are a common finding in clinical practice in this setting as well.

The predominance of Modic type 2 (25.7%) is consistent with the literature, where it is often reported as the most prevalent subtype, thought to represent a stable, chronic endpoint of vertebral marrow remodeling [2-5]. However, the most compelling finding of this study is the pronounced and statistically significant gender disparity in the distribution of Modic type 1 and type 3.

The significant male predominance of Modic type 1 changes suggests that the inflammatory, edematous pathway of endplate degeneration may be more active or prevalent in men in this population. Modic 1 is frequently associated with biomechanical stress, instability, and active symptoms [3, 4]. This association could reflect gender-specific occupational exposures to heavy lifting or repetitive axial loading, or perhaps

inherent differences in the inflammatory response to disc degeneration.

Conversely, the strong female association with Modic type 3 changes is particularly noteworthy. Modic 3 is a sclerotic, hypointense change considered by many as a bony response to long-standing stress. Its link to females in our cohort, especially among traders and housewives, may point to a degenerative pathway shaped by chronic, sustained mechanical load rather than acute instability. Furthermore, the potential influence of hormonal factors, particularly post-menopausal estrogen decline on bone metabolism and healing, could predispose women to a sclerotic rather than an edematous marrow response to disc injury [6, 7].

Limitations: The single-center, hospital-based design may affect generalizability. The cross-sectional nature prohibits establishing causality between gender/occupation and MC type. Detailed quantification of physical activity levels was not available.

5. CONCLUSION

In conclusion, Modic changes are a frequent finding on lumbar MRI in symptomatic patients in northern Cameroon, present in nearly half of the studied cohort. This study unveils a distinct gender-specific pattern: an inflammatory male phenotype (Modic 1) contrasted with a sclerotic female phenotype (Modic 3). These findings move beyond a simple description of prevalence to suggest that the pathophysiological expression of degenerative vertebral endplate changes may be fundamentally different between men and women in this context, likely mediated by a complex interplay of biomechanical stressors and biological factors. For clinicians, this underscores the importance of not just noting the presence of MCs, but carefully considering their type and the patient's gender and occupational history when interpreting lumbar spine MRI and formulating a management plan.

REFERENCES

1. Ravikanth R. Magnetic Resonance Evaluation of Lumbar Disc Degenerative Disease as an Implication of Low Back Pain. Neurol India. 2020. https://doi.org/10.4103/0028-3886.304091
2. Modic MT, Steinberg PM, Ross JS, Masaryk TJ, Carter JR. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology. 1988. https://doi.org/10.1148/radiology.166.1.3336678
3. Jensen TS, *et al.,* Vertebral endplate signal changes (Modic change): a systematic literature review of prevalence and association with non-specific low back pain. Eur Spine J. 2008. https://doi.org/10.1007/s00586-008-0770-2
4. Luoma K, *et al.,* Chronic low back pain in relation to Modic changes, bony endplate lesions, and disc degeneration in a prospective MRI study. Eur Spine J. 2016. https://doi.org/10.1007/s00586-016-4715-x
5. Zhang YH, *et al.,* The prevalence and distribution of Modic changes in the lumbar spine: a systematic review and meta-analysis. Eur Radiol. 2021.
6. Yang S, *et al.,* Can T2-weighted Dixon fat-only images replace T1-weighted images in degenerative disc disease with Modic changes on lumbar spine MRI? Eur Radiol. 2021. https://doi.org/10.1007/s00330-021-07946-2
7. Feng Z, *et al.,* The relationship between Modic changes and intervertebral disc degeneration in patients with chronic low back pain: a retrospective imaging study. J Back Musculoskelet Rehabil. 2020.