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Assessment of the Appropriateness and Factors Associated with Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

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A research thesis Submitted to the Department of Radiology and Radiology Technology, St. Paul's Millennium Medical College for Partial Fulfillment in the Requirement for Degree of specialty in Clinical Radiology

August, 2026

Addis Ababa, Ethiopia

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Acronyms and abbreviations

ACR	American college of radiology
LBP	Low Back Pain
LSMRI	Lumbar spine magnetic resonance imaging
MR	Magnetic resonance
MRI	Magnetic resonance imaging
SPHMMC	Saint Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Sciences
RBM	radiology benefits management

Abstract

Background: Magnetic resonance (MR) imaging is crucial for diagnosing lumbar spine diseases, effectively providing 3D visualization of spinal structures. Disease like disc degeneration and herniation are common, but routine imaging is often unnecessary within the first four to six weeks of presentation and before treatment. MRI should be reserved for persistent pain past six weeks or significant disorders known as red flags.

Objectives: To assess the Appropriateness and associated factors with Ordering Lumbosacral MR at St. Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia.

Methods: An institution based retrospective cross-sectional study design was conducted among all patients who underwent Lumbosacral MRI from all departments at SPHMM from November 1, 2025 to July 6, 2026. Systematic random sampling was employed to select participants based on total referrals for the MRI service. SPSS software (version 26) was used for data management and analysis, presenting results as percentages and frequency distribution tables; binary logistic regression analysis was used to identify factors associated with appropriateness. Applying both Bivariable and multivariable logistic regression analysis to identify factors associated with appropriateness of lumbosacral MRI ordering with calculating crude and adjusted odds ratios with 95% confidence intervals at a significance level of $p < 0.05$.

Results: A total of 384 patients who had a lumbar spinal MRI during the study period were included in the study. The majorities 144 (37.5%) were between age 35–50 years, followed by 19–34 years 104 (27.1%). About 294 (76.6%) (95% CI: 72.0%, 80.7%)) were classified as inappropriate lumbosacral MRI order. In multivariable logistic regression analysis, 19–34 years old (AOR=9.00, 95% CI: 3.32–24.35) 35–50 years (AOR=7.36, 95% CI: 3.00–18.04), 51–65 years (AOR=4.19, 95% CI: 1.69–10.38), poor documentation quality (AOR=9.05, 95% CI: 2.48–32.97), females patients (AOR=2.16, 95% CI: 1.19–3.91) , not documented radiculopathy (AOR=2.38, 95% CI: 1.24–4.57), no history of back injury or trauma (AOR=36.60, 95% CI: 9.06–148.0), no documented history of back injury/trauma (AOR=6.30, 95% CI: 1.15–34.30) were significantly associated with inappropriateness of lumbosacral MRI order.

Conclusion and recommendation: The study revealed that a significant number of lumbosacral MRI orders were inappropriate, with over 75% not meeting ACR criteria. Factors such as gender, radiculopathy, history of back injury or trauma, documentation quality, and age influenced appropriate ordering. Recommendations include enhancing the use of ACR

appropriateness criteria for MRI requests, focusing on specific age groups with higher odds of improper orders, ensuring comprehensive clinical information is documented, providing ongoing training on proper ordering guideline, developing an MRI request checklist, and utilizing quality improvement programs to analyze and address causes of inappropriate MRI requests.
Key Words: Appropriateness, Ordering, Lumbosacral MRI

1. Introduction

1.1 Background of study

Magnetic resonance (MR) imaging is the most effective non-invasive method for detecting lumbar diseases due to its ability to visualize spinal structures in 3D. The most prevalent abnormalities on MR imaging may include degenerative changes in the lumbar spine, such as disc degeneration, disc herniation, spinal canal stenosis, and facet joint disease (1).

These evidence-based clinical practice recommendations for routine imaging are unnecessary for the majority of patients, as significant improvements in function and pain usually occur within the first four weeks. Imaging is recommended after roughly six weeks of non-surgical treatment with no improvement, and it is required for patients suspected of having significant disorders such as cauda equina syndrome, cancer, fractures, or infections, which are known as red flag indicators. Furthermore, imaging adds significantly to LBP-related healthcare costs, both directly and indirectly (2).

According to the literature, 50-80% of adults suffer from spine-related disorders, specifically low back pain (LBP). Despite professional guidelines urging otherwise, MRI is frequently used for diagnostic imaging. In Canada, over 30% of LBP imaging is ruled inappropriate, and a study found that over 60% of MRIs and all CT scans for degenerative spine illness are unneeded, costing an estimated $24 million each year (3,4).

There is evidence that many patients lack structural abnormalities that correlate to their clinical symptoms, hence a considerable proportion of urgently requested scans are normal. This condition puts undue pressure on radiological services, which are already under financial duress, to do urgent scans due to the possibility of permanent function loss from delayed diagnoses. Prioritizing scanning requires identifying individuals who are likely to have structural abnormalities, but few research have looked at the clinical grounds for requesting urgent spine MRIs or the signs that signal such abnormalities (5).

There is a common misperception that an MRI is required to diagnose the origin of back pain. Despite its limitations, lumbar spine MR imaging is widely used for screening and its popularity is growing (6). Clinical recommendations, such as red flags, appropriateness criteria , radiology benefits management (RBM), and clinical decision support systems, have been created to

promote the proper use of lumbar spine MR imaging in back pain treatment. However, estimates imply that one-third to two-thirds of spinal MR imaging may be given incorrectly, indicating a mismatch between scientific knowledge and clinical practice (7).

Low back pain (LBP) is common in Ethiopia, particularly among students and working adults, and is mostly caused by urban occupational and lifestyle risks (8). This enormous burden increases demand for diagnostic services and puts a pressure on radiology departments, particularly in tertiary hospitals such as St. Paul's Hospital Millennium Medical College (SPHMMC) in Addis Ababa. However, there is a dearth of local information on the appropriateness of sophisticated imaging, such as lumbosacral MRI, leaving policymakers without the data needed to optimize imaging utilization and cost allocation. An evaluation of lumbosacral MRI orders at SPHMMC could yield significant insights for quality improvement, resource planning, and educational curriculum creation, as well as data to inform national imaging policy.

1.2 Statement of the problem

Globally, inappropriate lumbar MRI studies were significantly burden the health care system. Additionally, headache disorders are prevalent, affecting nearly 90% of adults (9).

Acute low back pain contributes significantly to years lived with disability, with a global prevalence ranging from 12% to 33%, affecting roughly 619 million people in 2020 (10). The majority of uncomplicated instances are self-limiting and do not require imaging; yet, many patients continue to undergo unnecessary MRI scans, which do not improve clinical outcomes and increase healthcare expenses. There is a need to address these inefficiencies to improve resource use, especially since lumbar disc abnormalities are frequently detected in asymptomatic patients. The American College of Radiology recommends MRIs only for patients who show potential "red flags."(11).

Inappropriate imaging studies, such as non-specific back pain without reg flags MRI scans of the lumbar spine, provide little patient benefit while incurring enormous expenditures, including unnecessary surgeries and delays for other patients. A reduction in such scans from 13.0% to 7.3% results in an annual savings of 214 MRI scans, allowing for better resource allocation to more urgent tests, improving efficiency and lowering patient wait times(12).

Imaging adds significantly to healthcare expenditures associated with low back pain (LBP), not only via direct expenses but also through indirect impacts such as needless tests and treatments.

Such imaging can result in needless procedures, increased painkiller use, and increased patient anxiety due to accidental results (13). Although guidelines advise against routine imaging for non-specific LBP, adherence in clinical practice is low; a 2018 review discovered that 35% of lumbar imaging referrals lacked red flags for serious diseases, and 32% were unsuitable due to insufficient clinical suspicion of pathology (14).

MRI plays an important role in the diagnosis of lumbar spine problems such as disc herniation and spinal stenosis. Regardless of its efficacy, following clinical guidelines is critical to avoiding needless imaging. According to research, a high rate of incorrect MRI prescriptions exists, highlighting the need for enhanced decision-making processes. Many MRIs lack obvious clinical indications, resulting in findings with minimal importance(15). Furthermore, inappropriate imaging procedures result to higher healthcare expenses with no additional benefits (16). There is a strong need for Assessment of the Appropriateness of Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia.

1.3 Significance of the study

This study examines the appropriateness of ordering a lumbosacral MRI at St. Paul's Hospital Millennium Medical College in Ethiopia. It emphasizes the increased demand for enhanced imaging, limited resources, and the necessity to eliminate superfluous studies. The findings was assist patients by reducing unnecessary treatments, waiting time and delays, doctors by improving decision-making and documentation, and radiology workers by decreasing workflow and increasing service quality. Hospital administrators can use the findings to improve resource allocation and build imaging request guidelines. Health policymakers was gather local evidence to inform national diagnostic imaging policies. Overall, the study's goal is to improve patient care, promote evidence-based procedures, and maximize the use of MRI resources in a tertiary hospital context.

Additionally, the findings was serve as a foundation for future research, benchmark appropriateness of ordering a lumbosacral MRI, and strengthen healthcare capacity by enhancing training and education for healthcare professionals in utilizing imaging. The knowledge generated was applicable to the study area and nationwide, guiding clinicians in identifying and addressing appropriateness of ordering a lumbosacral MRI and serving as baseline data for comparison with other studies

2. Literature review

Magnetic resonance imaging (MRI) is an important diagnostic tool for detecting lumbar spine abnormalities, especially in cases of low back pain. However, broad use has prompted concerns about the appropriateness of referrals, particularly when guidelines are not followed consistently. Unnecessary imaging may cause additional expenditures, patient concern, and clinical inefficiencies (17).

MRI is recommended for detecting spine diseases, although 26% to 44% of lumbar MRIs do not follow guidelines advising conservative treatment for new-onset low back pain (LBP) without red flags. Ordering unneeded MRIs does not improve outcomes and incurs large expenses, estimated at $300 million yearly in the United States (18). Mislabeling patients based on imaging data can have long-term consequences. Despite the low incidence of significant spine diseases and the long-term effectiveness of evidence-based guidelines, some patients and physicians continue to have misconceptions regarding the value of early imaging for non-specific LBP(16).

Lumbar spine magnetic resonance imaging (LSMRI) is recommended for patients with low back pain (LBP) who have systemic disease red flags or who are considering surgery due to signs of radicular compression, such as cauda equina syndrome or radicular pain from disk herniation, after 12 weeks of unsuccessful conservative treatment (19).

LSMRI is not recommended when there are no signs of systemic disease or radicular compression since the findings are irrelevant and do not help diagnosis or outcomes. Limiting unneeded diagnostic use improves healthcare quality and resource allocation while requiring an assessment of associated costs. The evidence for the incorrect use of LSMRI is sparse, with certain research indicating that a percentage of LSMRIs administered in Spain may be inappropriate, while their generalizability is uncertain (2).

MRI is excellent for lumbar spine imaging because it can effectively detect spinal infections, intra-spinal tumors, and degenerative discs due to reduced water content. MRI has equivalent accuracy in diagnosing herniated disks and spinal malignancies, although it is more sensitive. High-quality images necessitate defined protocols with imaging planes and sequences that are specifically matched to the equipment (20). However, the appropriateness of MRI is being questioned due to its high cost and impact on clinical results.

The study in New Delhi, India found that 71% (142) of the 200 referrals were deemed suitable, especially for situations involving red flags or chronic neurological problems. 29% (58) were inappropriate, frequently including acute back pain with no red signals or failed conservative treatment. General practitioners and emergency medicine specialists had the highest rates of incorrect referrals (43.5% and 37.2%, respectively), although orthopedics and neurosurgery showed higher adherence to standards (15).

Literature shows that inappropriate magnetic resonance imaging (MRI) increased healthcare costs. Appropriateness criteria for low back pain are a guideline to reduce these un- necessary MRIs. The study conducted in Nepal of the 368 cases, 177 (48.1%) were deemed appropriate, while 191 (51.9%) were inappropriate (17). More-over, the study conducted in Ontario, Canada indicated that baseline data collection was 51.6% suitable, 12.0% improper, and 36.3% incomplete (3). Similarly, The Singapore study reviewed MRI scan requests over a six-month period. Initially, 492 MRI scans revealed 64 (13.0%) incorrect instructions. Post-intervention data showed a decrease in incorrect orders, with 86 (9.1%) of 940 scans in 2021 and 38 (7.3%) of 521 scans in 2022 (12).

In a research in the Central Denmark Region that examined MRI referrals for lumbar spine diagnostics at a public hospital, 55% (2051 referrals) were categorized. Only 24.5% were rated appropriate, while 75.5% were declared inappropriate. Notably, 51% of improper referrals lacked preceding non-surgical therapy information, while 49% failed to mention the length of such therapies. Despite slight annual changes, the proportion of appropriate versus incorrect referrals stayed substantially constant between 2014 and 2018 (21).

The study conducted Korle-bu Teaching Hospital, Korle-bu, Accra, Ghana found 242 adult patients (140 females, 102 males) referred primarily from outpatient departments (58%). The study discovered that 39% of MRI requests were "usually appropriate," 36% "may be appropriate," and 25% "usually not appropriate," with the most common indications being low back pain (LBP) and sciatica (52.1%). The most common imaging finding was degenerative alterations (65.0%) (20).

2.1 Factors associated with Appropriateness of Ordering Lumbosacral MRI

The study in the United States comprised 55 primary care physicians (PCPs), with an 8.6% response rate. Both low (n = 33) and high guideline-concordant providers recognized the importance of LS-MRIs for specialty care referrals, but they differed in how environmental factors influenced LS-MRI ordering patterns. While both groups reported similar patient-related characteristics, such as beliefs in imaging's worth and provider pressure, they differed in provider-level factors, such as familiarity with guidelines and personal beliefs about LS-MRI (22).

A study conducted in New Delhi, India, found that increasing clinician education, strengthening documentation standards, and using decision support tools are effective ways for reducing improper MRI utilization. These enhancements not only improve patient care but also help to reduce healthcare expenses associated with unneeded imaging procedures (15). Similarly, another study conducted in the study conducted in Indian found that The most common diagnosis was lumbar disc bulge, followed by scoliosis, kyphosis, and infection. Walking difficulties, back injury, and referred leg pain were more likely to produce clinically significant abnormalities in lumbar MR imaging than simple back pain. The duration of pain was not associated with greater positive diagnostic rates. The conclusion underlines magnetic resonance imaging's superiority over x-rays in orthopedic spine surgery, highlighting its efficacy in assessing normal lumbar anatomy, disc chemistry, degeneration, and identifying ruptured discs (23).

Moreover, the study was conducted the local MRI protocol for low back pain was justified. To avoid wastefulness, MRI requests must be made carefully. MRI centers must prioritize requests from orthopedic specialists rather than the OPD. The predominant imaging finding was degenerative bone disease, which is detectable with conventional radiography (20).

The study found that using appropriateness criteria for the use of imaging technologies (Project ACUITY) in magnetic resonance imaging of the lumbar spine. The overall rate of incorrect scans decreased from 13.0% pre-intervention to 7.3% post-intervention (P = 0.01). Out of 124 unsuitable post-intervention studies, only one patient required surgery(12).

The study on lumbar spine MRI usage in Eastern China revealed no significant difference in positive rates between orthopedic surgeons and other specialists. Overuse of MRI was noted, especially in health assessment centers. To improve evidence-based practices for back pain, better professional training and clinical guidelines are necessary (1).

According to a study conducted at Jeddah's National Guard Hospital, lower back pain (LBP) with radiculopathy was the most common complaint (82.9%), followed by LBP without radiculopathy (12.8%) and limb pain alone. Notably, 72% of patients had negative MRI findings that could not explain their symptoms, whereas 28% had positive findings unrelated to their symptoms ($p < 0.001$). A comprehensive physical examination was performed on 27.5% of patients, with only 12% having good results. An MRI was requested for 72.5% of patients who did not receive a complete assessment. 88.2% of those who had MRI were managed conservatively, with only 6.7% requiring surgical intervention ($p < 0.04$) (16).

The conceptual framework for this study was adapted from previous literature and the American college of radiology appropriateness criteria for lower back pain imaging. the framework illustrates the relationship between patient related factor, clinical presentation factor, provider related factor and diagnostic /imaging relate factor with appropriateness of lumbosacral MRI ordering

2.3 Conceptual Framework

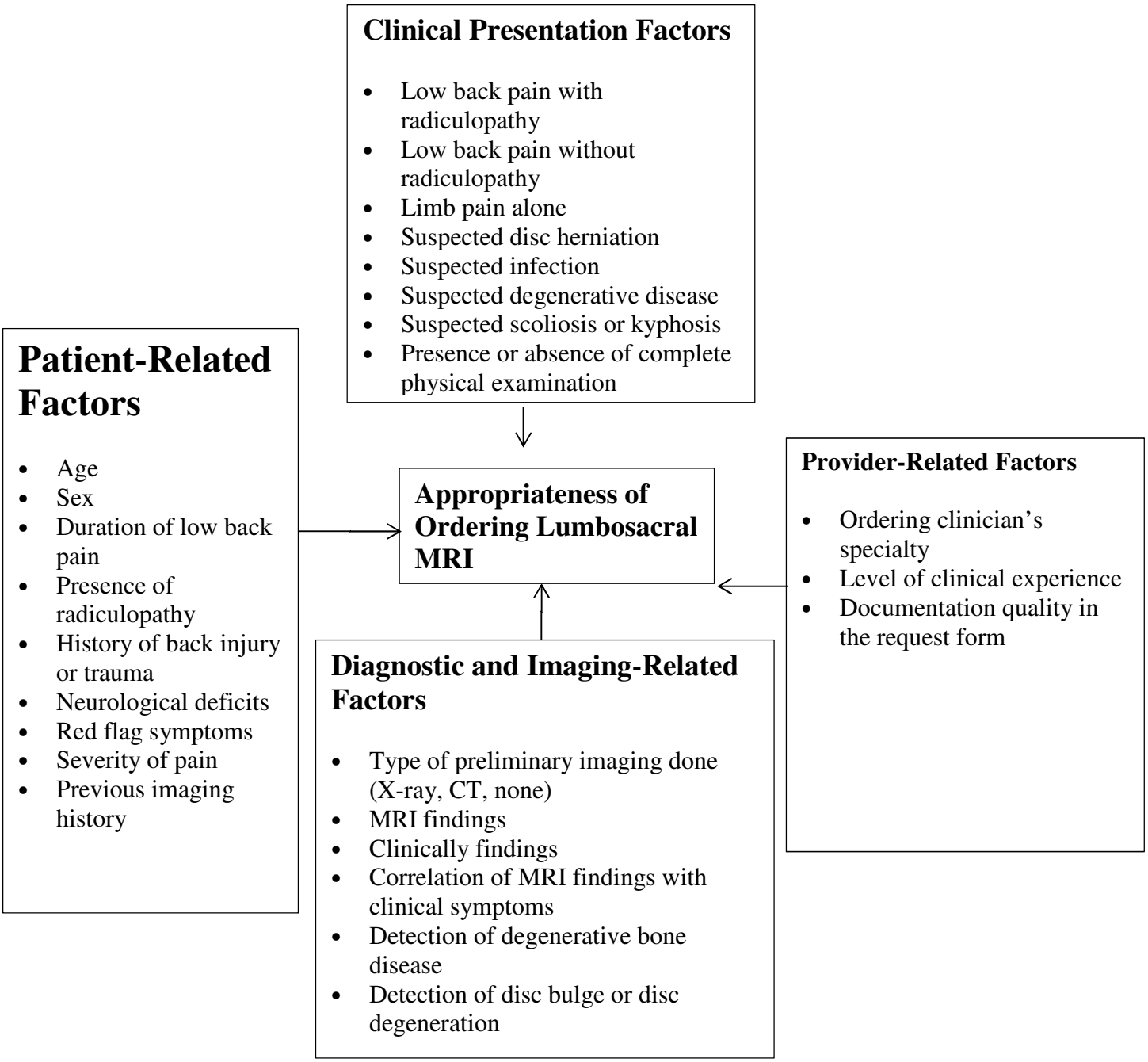


Figure 1: conceptual framework on Assessment of the Appropriateness of Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa.

3. Objectives

3.1 General objective

To assess the Appropriateness and factors associated with Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia from November 2025-July 2026

3.2 Specific Objectives:

- To determine the magnitude of appropriately ordered lumbosacral MRI examinations among patients presenting with LBP at St. Paul's Hospital Millennium Medical College between November 2025 and July 2026
- To identify factors Associated with inappropriateness of lumbosacral MRI ordering among patients presenting with LBP at St. Paul's Hospital Millennium Medical College between November 2025 and July 2026

4. Methods

4.1 Study setting and period

The study was conducted at SPHMMC, which is one of the largest hospitals in Ethiopia's capital city Addis Ababa and one of the few institutions in the country. It is a teaching hospital for health science students enrolled in various undergraduate programs in medicine and nursing specialty, residency tracks, sub-specialty fellowships and master's and Ph.D. programs, training nearly 2000 students each year. The hospital also provides tertiary-level clinical services in various disciplines with over 700 beds and is open 24 hours for emergency services. The college sees an average of 1200 emergency and outpatient clients daily. More than 200 lumbar spine MRI imaging investigations are being done monthly. The study was conducted between November 1, 2025, to July 6, 2026**.** Data extraction period was from July 15 to 30, 2026.

4.2. Study design

Institutional- based retrospective cross-sectional study design was conducted.

4.3. Population

4.3.1 Source of population

All patients who underwent lumbar spinal MRI examination during the study period.

4.3.2. Study population

All patient who fulfilled the eligibility criteria and were selected using systematic random sampling

4.4. Inclusion and exclusion criteria

4.4.1 Inclusion Criteria:

- The referrals for an MRI of the lumbar spine concerned patients ≥18 years of age
- The referrals were received by the radiology department and checked for contraindications for MRI.

4.4.2 Exclusion Criteria:

- Patients with contraindication for lumbar MRI
- Patient age <18 years of age

4.5. Sample Size Determination

The sample size was determined using the single population proportion formula. The sample size was determined by taking variability of proportion of 50 % since there is no similar study takes 50%.

n = sample size

$z_{\frac{\alpha}{2}}$ = critical value for normal distribution at 95% confidence interval (CI) which equals to 1.96.

p = Proportion 50% (since from previous studies)

D = Precision (marginal error) = 0.05

$$n = \frac{[(z^2 * \alpha/2)2*(p(1-p)]}{d^2}$$

$$n = \frac{[(1.96)^2 * 0.50*(1-0.50)]}{0.05^2}$$

$$n = 384$$

The calculated sample size was 384, and all 384 selected lumbosacral MRI examination were included in the final analysis.

4.6 Sampling technique

Systematic random sampling method was employed to select study participants (sample population) who underwent lumbosacral MRI at SPHMMC during study period. A systematic random sampling technique was used to select study participants after the value of K is determined. The value of K was determined by dividing the total number of referrals for an MRI of the lumbar spine service by sample size (n = 384). the first participant was selected by lottery using random sampling and subsequently every Kth interval was included in study. A total of 1,884 lumbosacral MRI examinations were performed between November 1 and July 6. Using a systematic random sampling technique, 384 MRI examinations were selected for inclusion. Consequently, a total of 384 lumbosacral MRI examinations were included in the final analysis.

4.7. Study Variables

4.7.1 Dependent Variables\

- Appropriateness of Ordering Lumbosacral MRI

4.7.2 Independent Variables

Patient-Related Factors

- Age
- Sex
- Duration of low back pain
- Presence of radiculopathy
- History of back injury or trauma
- Neurological deficits
- Red flag symptoms
- Severity of pain
- Previous imaging history

Clinical Presentation Factors

- Low back pain with radiculopathy
- Low back pain without radiculopathy
- Limb pain alone
- Suspected disc herniation
- Suspected infection
- Suspected degenerative disease
- Suspected scoliosis or kyphosis
- Presence or absence of complete physical examination

Provider-Related Factors

- Ordering clinician's specialty

- Level of clinician
- Documentation quality in the request form

Diagnostic and Imaging-Related Factors

- Type of preliminary imaging done (X-ray, CT, none)
- Clinical findings
- Detection of degenerative bone disease
- Detection of disc bulge or disc

4.8 Operational terms

Magnetic resonance imaging (MRI) is commonly used to diagnose LBP and is invaluable in identifying specific spinal conditions like disc herniation, tumors, and infections. It is an important diagnostic tool for detecting lumbar spine abnormalities, especially in cases of low back pain (15)

An MRI imaging referral: is required to contain information about MRI contraindications and a narrative text, including a short summary of the patient's medical history explaining why the referral is relevant according to current guidelines (21).

Appropriateness of Ordering Lumbosacral MRI: Based on the narrative text, referrals were classified as appropriate or in-appropriate according to the 2021 version of the ACR Imaging Appropriateness (2).

4.9 Data collection tool, methods and Procedure

The data were collected through review of the existing MRI request forms and medical records of patients who underwent lumbosacral MRI during the study period. Patient-related factors for lumbosacral MRI requests include demographic features, clinical characteristics like pain duration and severity, and the presence of red-flag symptoms. Clinical presentation factors also play a role, particularly the nature of symptoms and whether thorough clinical assessments were conducted. Provider-related factors involve the clinician's specialty, experience, adherence to guidelines, and external pressures affecting MRI utilization. Lastly, diagnostic factors, including previous imaging and the correlation of MRI findings with symptoms, are crucial for determining the appropriateness of the procedure. Referrals were evaluated as appropriate or

inappropriate based on the narrative text using the 2021 ACR Imaging Appropriateness Criteria for LBP [3]. These criteria outline seven types of suitable MRI referrals ('Variants 1-7'): (Variant 1) acute lower back pain with or without radiculopathy, no red flags. no prior management. (variant 2) subacute or chronic lower back pain with or without radiculopathy, no red flags. no prior management (Variant 3) candidate for surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks optimal medical (Variant 4) lower back pain with suspected cauda equine syndrome (Variant 5) New or worsening symptoms or clinical findings after previous lumbar surgery; (Variant 6) lower back pain with or without radiculopathy .one or more of the following low velocity trauma, osteoporosis, elderly individual, or chronic steroid use .(variant 7) suspicions for cancer , infection ,or immunosuppression. If the MRI referrals did not include information on any of the disorders, they would be considered inappropriate (Variant 1). Inappropriate referrals were split into three categories: (1a) no information on prior non-surgical treatment, (1b) no information on the duration of non-surgical treatment, or (1c) additional causes (e.g., inaccuracies such as missing narrative text, referrals of cervical/thoracic spine)

4.10 Data Quality Assurance

The data collection method was improved by exchanging experience, training, and monitoring. A one-day training session was held for data collectors and supervisors, followed by a pretest on 5% of the research population to identify any necessary changes. Modifications were addressing unclear questions, reducing logistics, and improving data collection training. To reduce errors, quality assurance procedures were used, such as aligning the data collection form with related research and reviewing the data on a continuous basis.

4.11 Data management and Analysis

Once the data is collected and checked for completeness and accuracy, it was sorted, categorized, and summarized. The data were analyzed using SPSS software version 26. Results were presented using percentages, frequency distribution tables, and graphs. The statistical relationship between Magnitude of Appropriateness of Ordering Lumbosacral MRI and independent variables, was determined by binary logistic regression analysis. Both Bivariable and multivariable logistic regression were carried out. The multivariate analysis only considered variables whose p-value in the bivariate analysis is less than 0.25. In order to account for and

adjust for potential confounding variables, multivariable analysis was used. With 95% confidence intervals and a p-value of less than 0.05, crude and adjusted odds ratios were used to calculate statistical significance. The Hosmer-Lemeshow goodness-of-fit test was checked for model fitness.

4.12. Ethical clearance

Ethical approval was obtained from the departments of research committee and SPHMMC's research review board. After obtaining the ethical letter, SPHMMC's study IRB was presented to the radiology department, allowing me to use patients' medical records. Patients' information, such as their names and addresses, was not recorded throughout data collection so order to protect their confidentiality.

4.12. Plan for dissemination of Results

The results of the study will be documented and submitted to departments of radiology, departments of neurology and department of neurosurgery and all relevant bodies in SPHMMC and other health facilities. Publications will be made in the Ethiopian Journal of Health Sciences.

5. Results

5.1 Socio-demographic Characteristics of Participants

A total of 384 patients who underwent lumbar spinal MRI were included in the study. The majorities 144 (37.5%) were aged 35–50 years, followed by 19–34 years 104 (27.1%). More than two-thirds of patients, 254 (66.1%), were female **(Table 1).**

Table 1: Socio-demographic Characteristics Patients undergoing Lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384)

Variables	Category	Frequency (n)	Percentage (%)
Age of the participants	19–34 Years	104	27.1
	35–50 Years	144	37.5
	51–65 Years	97	25.3
	>65 Years	39	10.2
Gender	Female	254	66.1
	Male	130	33.9

5.2 Clinical and patient related factors

The study findings revealed that, majority had >6 weeks, 324 (84.4%), of duration of low back pain; the radiculopathy was present in 168 (43.8%), while 135 (35.2%) had no radiculopathy. Most patients had no history of back injury or trauma, 291 (75.8%), and no neurological deficits, 293 (76.3%). Similarly, red flag symptoms were absent in 274 (71.4%). Almost all patients, 373 (97.1%), had no previous imaging history **(Table 2).**

Table 2: Patient-Related Factors among patients undergoing lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384)

Variables	Category	Frequency (n)	Percentage (%)
Duration of low back pain	<4 weeks	40	10.4
	4–6 weeks	20	5.2
	>6 weeks	324	84.4
Presence of radiculopathy	No	135	35.2
	not documented/unknown	81	21.1
	Yes	168	43.8
History of back injury or trauma	No	291	75.8
	not documented/unknown	72	18.8
	Yes	21	5.5
Neurological deficits	No	293	76.3
	not documented/unknown	81	21.1
	Yes	10	2.6
Red flag symptoms	No	274	71.4
	not documented/unknown	81	21.1
	Yes	29	7.6
Previous imaging history	None	373	97.1
	MRI	9	2.3
	X-ray	2	0.5

5.3 Clinical Presentation of participants

The results showed that low back pain with radiculopathy was documented in 62 (16.1%) patients. Similarly, Low back pain without radiculopathy was present in 10 (2.6%) patients, additionally, Suspected disc herniation was present in 27 (7.0%) patients, while 274 (71.4%) had no suspected disc herniation. About 131 (34.1%) patients presented with suspected degenerative disease, while 175 (45.6%) had no suspected degenerative disease. Furthermore, about 297 (77.3%) had no suspected scoliosis/kyphosis and 83 (21.6%) were not documented/unknown, suspected scoliosis/kyphosis was present **(Table 3).**

Table 3: Clinical Presentation Factors among Patients Undergoing Lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384)

Variables	Category	Frequency (n)	Percentage (%)
Low back pain with radiculopathy	No	237	61.7
	not documented/unknown	85	22.1
	Yes	62	16.1
Low back pain without radiculopathy	No	292	76.0
	not documented/unknown	82	21.4
	Yes	10	2.6
Limb pain alone	No	297	77.3
	not documented/unknown	83	21.6
	Yes	4	1.0
Suspected disc herniation	No	274	71.4
	not documented/unknown	83	21.6
	Yes	27	7.0
Suspected infection	No	295	76.8
	not documented/unknown	80	20.8
	Yes	9	2.3
Suspected degenerative disease	No	175	45.6
	not documented/unknown	78	20.3

	Yes	131	34.1
Suspected scoliosis/kyphosis	No	297	77.3
	not documented/unknown	83	21.6
	Yes	4	1.0
Clinical indication of MRI	Acute lower back pain without radiculopathy	8	2.1
	Chronic lower back pain with radiculopathy	16	4.2
	Chronic lower back pain without radiculopathy	195	50.8
	Rule out degenerative disc disease	46	12.0
	Rule out compressive myelopathy	10	2.6
	Rule out lumbosacral metastasis	7	1.8
	Paraparesis	2	0.5
	Monoparesis	2	0.5
	Paraplegia	2	0.5
	Paraspinal mass	2	0.5
	Lower back pain rulesout spondylodiscitis	5	1.3
	RTA and history of lower back trauma	3	0.8
	Scoliosis	3	0.8
	Not documented/unknown	26	6.8
	Sciatica/peripheral neuropathy	18	4.7
	Other	37	9.6

NB: Other included: Acute lower back pain with radiculopathy, Chronic lower back pain with previous history of lumbar surgery, Rule out vertebral multiple myeloma, for check-up

5.4 Provider-Related Factors

The results showed that nearly half of the MRI requests, 187 (48.7%), were ordered by residents, followed by specialists (19.50%), general practitioners (10.90%), and interns (6.00%). About 14.80% of lumbosacral MRI orders were where the clinician level was not documented. Regarding documentation quality, 69.30% of the records had good documentation, while 30.70% had poor documentation **(Table 4).**

Regarding the distribution of lumbosacral MRI requested by ordering department, Rheumatology had the highest number of requests, with 130 examinations. Of these, 33 were appropriate and 106 were inappropriate. Neurology had the second highest number of requests, with 59 examinations, including 21 appropriate and 38 inappropriate orders. Family medicine had 25 requests, with 5 appropriate and 20 inappropriate orders, while Medical OPD had 22 requests, including 8 appropriate and 14 inappropriate orders. Among the larger department, Emergency had 14 requests, of which 8 were appropriate and 6 were inappropriate. Emergency OPD has 14 requests, of these 8 were appropriate. Requests from central triage and ART OPD had almost inappropriate request. Around 84 requests had no documented department referral.

Table 4: Provider-Related Factors among Patients Undergoing Lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384)

Variables	Category	Frequency (n)	Percentage (%)
Clinician level	General Practitioner	42	10.9
	Intern	23	6.0
	Resident	187	48.7
	Specialist	75	19.5
	not documented/unknown	57	14.8
Documentation quality	Poor	118	30.7
	Good	266	69.3

5.5 Diagnostic and Imaging-Related Factors

Regarding diagnostic and imaging-related factors, none of the 384 patients underwent preliminary imaging. In 102 (26.6%) patients, MRI results showed a link with clinical symptoms; in 270 (70.3%) patients, there was no correlation. 326 patients (84.9%) had degenerative alterations, while 325 patients (84.6%) had disk bulge/disc herniation **(Table 5)**.

Table 5: Diagnostic and Imaging-Related Factors among Patients Undergoing Lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384)

Variables	Category	Frequency (n)	Percentage (%)
Type of preliminary imaging	Not documented	384	100.0
MRI findings correlate with symptoms	No	270	70.3
	not documented/unknown	12	3.1
	Yes	102	26.6
Degenerative changes detected	No	58	15.1
	Yes	326	84.9
Disc bulge/disc herniation	No	59	15.4
	Yes	325	84.6
MRI findings/diagnosis	Normal/unremarkable	42	10.9
	Early degenerative changes	54	14.1
	Isolated L4/5 degenerative changes	6	1.6
	Disc bulge/dehydration	11	2.9
	Mild degenerative changes	134	34.9
	Mild to moderate degenerative changes	23	6.0

	Moderate degenerative changes	47	12.2
	Moderate to severe degenerative changes	30	7.8
	Severe degenerative changes	15	3.9
	Lumbar compressive vertebral body fractures and vertebral plana	5	1.3
	Spondylodiscitis	2	0.5
	Vertebral metastasis	3	0.8
	Other	12	3.1

NB: Other includes *Incidental vertebral hemangioma, Perineural cyst/epidural lipoma, Scoliosis, Other isolated or unclassified findings*

5.6 Magnitude of appropriately ordered lumbosacral MRI examinations

Overall, 90 (23.4%) of MRI requests were classified as Appropriate, while 294 (76.6%) (95% CI: 72.0%, 80.7%)) were classified as Inappropriate. According to the ACR Appropriateness Assessment, most MRI requests were classified as Variant 2, 288 (75.0%), followed by Variant 3, 45 (11.7%), and Variant 7, 33 (8.6%). The main reason for inappropriate MRI ordering was no conservative treatment before MRI, reported in 188 (49.00%) cases. This was followed by no red flag symptoms in 168 (62.00%) cases and incomplete clinical information in 84 (31.00%) cases. Conservative treatment <6 weeks was reported in 12 (4.40%) cases. Overall, the most frequently documented reasons for inappropriate MRI ordering were the absence of conservative treatment before MRI and the absence of red flag symptoms.

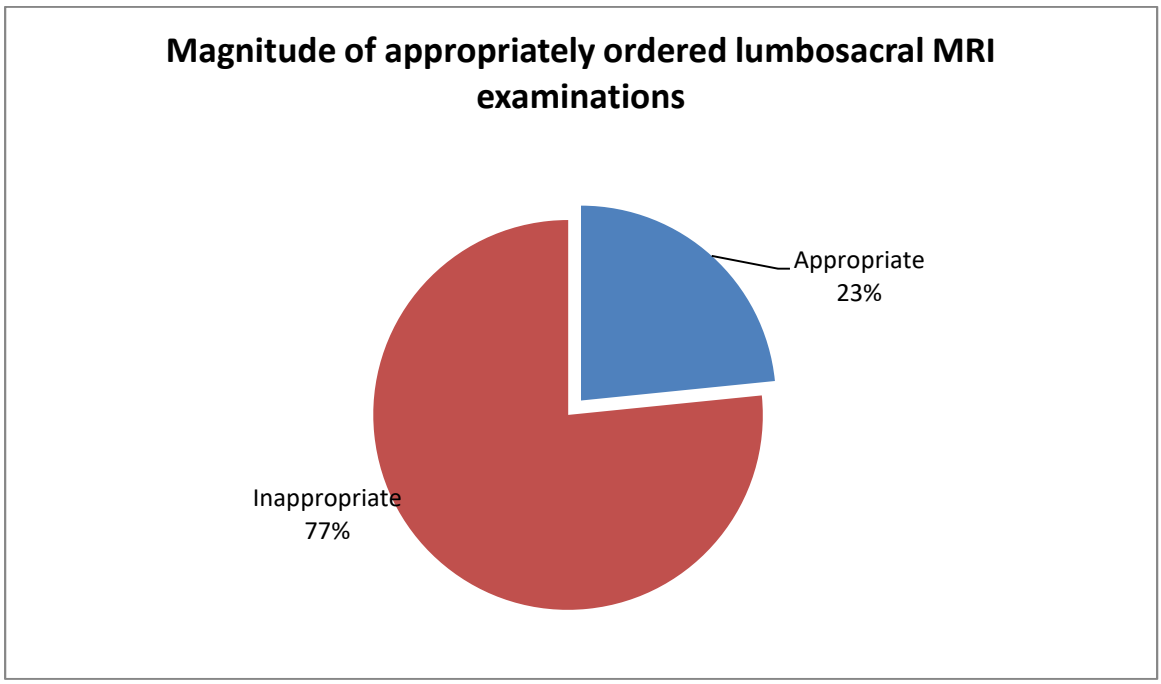


Figure 2: Magnitude of appropriately ordered lumbosacral MRI examinations among Patients Undergoing Lumbosacral MRI, SPHMMC, Addis Ababa, Ethiopia, 2026 (n=384).

5.7 Factors associated with inappropriateness of lumbosacral MRI order

To identify factors associated with inappropriateness of lumbosacral MRI order, variables with a p-value less than 0.25 in the bivariable logistic regression analysis were included in the multivariable logistic regression model. These variables included gender, duration of low back pain, presence of radiculopathy, history of back injury or trauma, documentation quality, and age.

In multivariable logistic regression analysis, gender, presence of radiculopathy, history of back injury or trauma, documentation quality, and age were significantly associated with inappropriateness of lumbosacral MRI order. The odds of inappropriate Lumbosacral MRI order were 9.00 times more likely among participants between age 19–34 years compared with those age >65 years (AOR=9.00, 95% CI: 3.32–24.35, p<0.001) and 7.36 times more likely among participants aged 35–50 years compared with those age >65 years (AOR=7.36, 95% CI: 3.00–18.04, p<0.001) and 4.19 times more likely among participants age 51–65 years compared with those age >65 years (AOR=4.19, 95% CI: 1.69–10.38, p=0.002). The odds of inappropriate Lumbosacral MRI order were 9.05 times more likely with poor documentation quality compared with those with good documentation quality (AOR=9.05, 95% CI: 2.48–32.97, p=0.001). The odds of inappropriate Lumbosacral MRI order were 2.16 times more likely among females compared with males (AOR=2.16, 95% CI: 1.19–3.91, p=0.012).

Participants with no documented radiculopathy had 2.38 times higher odds of inappropriate MRI ordering compared with those with radiculopathy (AOR=2.38, 95% CI: 1.24–4.57, p=0.009). Patient with no history of back injury or trauma had 36.60 times higher odds of inappropriate MRI ordering compared with those who had a history of back injury or trauma (AOR=36.60, 95% CI: 9.06–148.00, p<0.001). Participants with no documented history of back injury or trauma also had higher odds of inappropriate MRI ordering compared with those with a documented history of injury or trauma (AOR=6.30, 95% CI: 1.15–34.30, p=0.031) **(Table 6).**

Table 6: Factors associated with inappropriateness of lumbosacral MRI order among patients with low back pain, Addis Ababa, Ethiopia, 2026 (n=384).

Variables	Category	Lumbosacral MRI order		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Appropriate n (%)	Inappropriate n (%)				
Age of participants	19–34 Years	17 (16.30)	87 (83.70)	8.19 (3.58–18.75)	<0.001	9.00 (3.32–24.35)	**<0.001***
	35–50 Years	25 (17.40)	119 (82.60)	7.62 (3.51–16.55)	<0.001	7.36 (3.00–18.04)	**<0.001***
	51–65 Years	24 (24.70)	73 (75.30)	4.87 (2.20–10.76)	<0.001	4.19 (1.69–10.38)	**0.002***
	>65 Years	24 (61.50)	15 (38.50)	1.00		1.00	
Gender	Female	47 (18.50)	207 (81.50)	2.18 (1.34–3.53)	0.002	2.16 (1.19–3.91)	**0.012***
	Male	43 (33.10)	87 (66.90)	1.00		1.00	
Duration of low back pain	<4 weeks	5 (12.50)	35 (87.50)	2.41 (0.91–6.36)	0.075	1.28 (0.42–3.90)	0.664
	4–6 weeks	2 (10.00)	18 (90.00)	3.10 (0.70–13.64)	0.135	1.55 (0.28–8.54)	0.612
	>6 weeks	83 (25.60)	241 (74.40)	1.00		1.00	
Presence of radiculopathy	No	23 (17.00)	112 (83.00)	2.77 (1.60–4.80)	<0.001	2.38 (1.24–4.57)	**0.009***
	not documented	6 (7.40)	75 (92.60)	7.12 (2.92–17.33)	<0.001	3.67 (0.87–15.4)	0.075
	Yes	61 (36.30)	107 (63.70)	1.00		1.00	
History of back injury or	No	60 (20.60)	231 (79.40)	23.1 (6.58- 81.0)	<0.001	36.6 (9.06–148.0)	**<0.001***
	not	12 (16.70)	60 (83.30)	30.0 (7.62-118.1)	<0.00	6.30 (1.15–34.3)	**0.031***

trauma	documented				1		
	Yes	18 (85.70)	3 (14.30)	1.00		1.00	
Documentation quality	Poor	6 (5.10)	112 (94.90)	8.62 (3.64–20.38)	<0.001	9.05 (2.48–32.97)	**0.001***
	Good	84 (31.60)	182 (68.40)	1.00		1.00	

NB: *COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio; CI = Confidence Interval; 1 = Reference; * = statistically significant.*

6. Discussion

This study assessed appropriateness and factors associated with ordering Lumbosacral MRI among adults who underwent LSMRI at St Paul's Hospital Millennium Medical College using the 2021 American college of Radiology (ACR) appropriateness criteria. In the present study ,only 90 (23.4%) of MRI requests were appropriate, while 294 (76.6%) (95% CI: 72.0%, 80.7%) were inappropriate based on the ACR Appropriateness criteria. This finding indicates a low level of adherence to evidenced -based imaging recommendation and suggests substantial over- utilization of MRI in the evaluation of lower back pain within the study setting. The proportion of appropriately ordered Lumbosacral MRI examination observed in the present study was lower than the study conducted in Canada (51.6% were appropriate), Nepal (48.1% were appropriate) and New Delhi India (71% were appropriate) (17). the study conducted in Korle-bu Teaching Hospital, Korle-bu, Accra, Ghana 39% were appropriate (20).According to the ACR appropriateness criteria , imaging is generally no recommended for patients with uncomplicated acute or subacute lower back pain without red flag features or failure of conservative management (24). In contrast, the finding of present study was similar to that reported from the Central Denmark Region 24.5% were appropriate (21). Difference in adherence to clinical guidelines, availability of decision support system, local imaging practices and documentation quality may explain these variations. Furthermore, the absence of structured MRI requests checklist and routine appropriateness screening in the local setting may contribute to the lower compliance with established imaging guidelines

Age was significantly associated with the appropriateness of lumbosacral MRI ordering. patients aged 19-34 years (AOR=9.00, 95% CI: 3.32–24.35), 35-50 years (AOR=7.36, 95% CI: 3.00–18.04) and 51-65 years (AOR=4.19, 95% CI: 1.69–10.38) demonstrated lower odds of appropriate MRI ordering compared with patients older than 65 years. This finding may be explained by the higher prevalence of degenerative spinal disease, vertebral fractures, malignancy and other spinal conditions among older individuals, which more frequently satisfy ACR indication for MRI. In contrast younger patients are commonly presents with nonspecific lower back pain. A condition which imaging is generally not recommended during the early stages unless red-flag symptoms are present.

Female sex was independently associated with lower appropriateness of MRI ordering (AOR=2.16, 95% CI: 1.19–3.91). Although the exact explanation is unclear, this finding may reflect differences in healthcare seeking behavior symptom reporting, clinician referral patterns,

or underlying clinical characteristics that were not captured in the study. similar sex related variation in imaging utilization has been reported in previous health care utilization studies. however, because evidence specifically linking sex to MRI appropriateness is limited, this finding should be interpreted cautiously and warrants further study.

The presence of documented radiculopathy was significantly associated with increased appropriateness of MRI ordering. This finding is clinically plausible because radiculopathy is an important indication for lumbar spine MRI, particularly in patients with persistent symptoms despite conservative management or when surgical intervention is being considered. ACR appropriateness criteria recognized radiculopathy accompanied by persistent or progressive symptoms as a scenario in which MRI may be appropriate. Therefore, adequate documentation of radicular symptom likely improved adherence to guideline-based imaging recommendations.

Similarly, patients with a documented history of back injury or trauma were more likely to have appropriately ordered MRI examinations. Those findings are consistent with ACR recommendations, which consider MRI appropriateness in selected patients with lower back pain accompanied by trauma, osteoporosis, advanced age or chronic steroid use. Trauma related clinical presentation increases the likelihood of structural abnormalities that may require advanced imaging evaluation.

Documentation quality was another important factor associated with appropriateness. Patients whose request forms contained adequate clinical information were more likely to have appropriately ordered MRI examination. Comprehensive documentation enables radiologists and referring clinicians to assess whether imaging indications meet established criteria. Inadequate clinical information may lead to unnecessary imaging difficulty in appropriateness assessment, and inefficient utilization of radiology resources. This finding highlights the importance of improving documentation practices and implementing structured MRI requests form that capture key clinical indicators and red flag symptoms.

In multivariable logistic regression analysis, gender, presence of radiculopathy, history of back injury or trauma, documentation quality, and age were significantly associated with inappropriateness of lumbosacral MRI order.

The study finding was higher than the study conducted in Canada, over 30% of LBP imaging is ruled inappropriate, (3,4), in United States MRI is recommended for detecting spine diseases, although 26% to 44% of lumbar MRIs do not follow guidelines advising conservative treatment for new-onset low back pain (LBP) without red flags (18), New Delhi, India 29% (58) were inappropriate, (15), The study conducted in Nepal (51.9%) were inappropriate (17), Ontario, Canada 48.2% (3), Singapore study (13.0%) (12), Korle-bu Teaching Hospital, Korle-bu, Accra, Ghana 61% (20).

This discrepancy may stem from differing adherence to imaging guidelines, professional procedures, referral systems, patient expectations, and the availability of alternative diagnostic choices could all contribute to this disparity. Inappropriate MRI ordering were also substantially linked with inadequate reporting of clinical observations(1). Not every patient with radiculopathy or trauma needs an MRI right once, especially if there are no obvious red-flag symptoms(23). Furthermore, reducing needless MRI requests can be achieved by promoting suitable conservative management methods, improving clinical documentation quality, and increasing adherence to ACR criteria(15).

The current study finding was consistent with the study conducted in Central Denmark Region 75.5% were declared inappropriate (21). Similar clinical decision-making styles and adherence to evidence-based imaging recommendations could be the cause of the resemblance. The need to better adhere to imaging guidelines and improve clinical assessment before ordering lumbosacral MRI is highlighted by MRI requests for patients with low back pain who might be treated conservatively, particularly in the absence of clear reasons or red-flag symptoms.

In the present study found that, Participants aged 19–34, 35–50, and 51–65 years had higher odds of inappropriate MRI ordering compared with those aged >65 years. This may be related to the higher likelihood of nonspecific low back pain among younger patients, where conservative management is often appropriate. This finding is supported by the Indian study, which reported

that simple back pain was less likely to produce clinically significant MRI findings compared with back injury and referred leg pain (23).

The study also found that Females were 2.16 times more likely to have inappropriate MRI orders compared with males. This may be related to differences in healthcare-seeking patterns and clinical decision-making. The US study also reported that patient-related factors and provider beliefs influenced MRI ordering practices (22).

Furthermore, the study found that Participants without radiculopathy had higher odds of inappropriate MRI ordering compared with those with radiculopathy. This is consistent with the Jeddah study, where radiculopathy was a common reason for MRI referral; however, many patients still had MRI findings that did not explain their symptoms, indicating that radiculopathy should be supported by a complete clinical assessment (16). Additionally, the current study also found that duration of low back pain was not significantly associated with inappropriate MRI ordering. This is consistent with the Indian study, which found that duration of pain was not associated with a higher rate of positive MRI findings (23).

The current study showed that participants without a history of back injury or trauma had substantially higher odds of inappropriate MRI ordering. This finding is consistent with the Indian study, which reported that back injury was more likely to be associated with clinically significant appropriate MRI order than simple back pain (23). the association between history of back injury or trauma and MRI ordering appropriateness should be interpreted with caution because some estimates had relatively wide confidence intervals. The wide intervals indicate limited precision and may be related to small number of participates in some categories .nevertheless the observed direction of association is clinically plausible because trauma may represent an important indication for spinal imaging

The study found that poor documentation was strongly associated with inappropriate MRI ordering. Patients with poor documentation had 9.05 times higher odds of inappropriate MRI orders compared with those with good documentation. This finding agrees with the New Delhi study, which emphasized improved documentation, clinician education, and decision-support tools to reduce inappropriate MRI utilization (15). Similarly, the Jeddah study showed that many patients underwent MRI without adequate clinical assessment (16).

7.0 Limitation of the study

Despite the extensive efforts in conducting this study, there are a few limitations:

- Retrospective study and the study relied on secondary data (medical records); this may have impacted on the reliability of the findings
- Single study settings may limit the generalizability of findings.
- Study relied on secondary data some variable not found in charts it might affect the result of the research i.e. geographic factors and transportation

7.1 strengths

This study is among the first studies conducted at the SPHMMC to assess the appropriateness of lumbosacral MRI ordering using internationally recognized ACR criteria.

The study addressed an important quality -improvement issue with direct implication for patient care and resource utilization

Systematic random sampling was employed to reduce selection bias.

The findings provide baseline evidence for future imaging utilization studies in Ethiopia

8. Conclusion

Overall, the findings of this study demonstrate a substantial gap between evidence-based recommendation and clinical practice regarding lumbosacral MRI utilization. Only 23.4% of MRI request ere classified as appropriate according to the 2021 ACR appropriateness criteria , while 76.6% were classified as inappropriate. Younger age, female sex, absence of documented radiculopathy , absence of history of back trauma and poor documentation were significantly associated with higher odds of inappropriate MRI ordering. The findings of this study provide valuable insights into the current practices regarding MRI.The findings highlight the need to strengthen adherence to ACR Appropriateness Criteria, improve clinical documentation, and implement standardized MRI request processes and clinician education to improve the appropriateness of lumbosacral MRI utilization

9. Recommendation

Based on the study's findings, numerous recommendations are offered to reduce inappropriate MRI requests, St. Paul's Hospital Millenium Medical College should increase the use of the ACR Appropriateness criteria for lumbosacral MRI orders based on the study's findings. Those between the ages of 19 and 34, 35 and 50, and 51 and 65 should receive extra attention because they had greater odds of receiving improper orders than those over 65 ages. Healthcare providers should make sure that all pertinent clinical information, including radiculopathy and any history of back injuries or trauma and red flag symptoms, conservative treatment duration is thoroughly detailed on lumbosacral MRI request forms in order to increase the quality of documentation. It is essential to provide ongoing training on proper lumbosacral MRI ordering procedures, emphasizing the ACR Appropriateness criteria and required clinical documentation. Additionally, the hospital should analyze lumbosacral MRI requests and identify contributing causes to improper ordering through ongoing quality improvement programs. Reducing improper lumbosacral MRI orders and facilitating appropriate MRI service utilization can be achieved by closely adhering to the ACR criteria, improving clinical assessments, and increasing documentation quality.

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St. Paul's Hospital
Millennium Medical College
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Annex I: English Version information sheet

Greetings - Hello!

My name is Nejat Seid (MD, Radiology Resident) I am working as data collector in the research Conducted by who is conducting this research for the partial fulfillment Degree of specialty in Clinical Radiology Saint Paul's Hospital Millennium Medical College, department of Clinical Radiology. I am trying to assess the "Appropriateness and factors associated with Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia".

Introduction: You are selected to participate in this study because you are currently attending one of the selected health centers for the study purpose. Your participation is purely based on your willingness, and you have the right to choose not to take part in this study.

Purpose: I am hopeful that this research will benefit all patients who had Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia among patients coming for Ordering Lumbosacral MRI service at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia.

Procedure: To assess the magnitude of the Appropriateness and factors associated with Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia". You are invited to take part in this project. If you are willing to participate in this project, you need to understand and say yes on the agreement form. Then after, you will fill out the questionnaire with the help of the data collector. All your responses and the results obtained were kept confidential by using coding system whereby no one had access to your response.

Risk/ Discomfort: By participating in this research project, you may feel that it has some discomfort especially on spending time about 20-30 minutes. Researcher hopes you will participate in the study for the sake of the benefit of the research result. I am assured you that there is no risk due to your participation in this project.

Benefits: There may not be direct benefit to you, but your Participation is likely to help us in assessment of "Assessment of the Appropriateness and factors associated with Ordering Lumbosacral MRI at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia". Ultimately, this will help us to identify the gap and take the appropriate intervention by the authorized stakeholder. You will not be provided with any incentive or payment to take part in this project.

Confidentiality: The information collected from this research project was kept confidential and information about you that was collected by this study was stored in a file, without your name, but a code number assigned to it. In addition, it was not revealed to anyone except the principal investigator and was kept locked with key.

Right to refuse or withdraw: You have full right to refuse from participating in this research. You can choose not to respond to some or all questions if you do not want to give your response. You have also the full right to withdraw from this study at any time you wish, without losing any of your right. If you have any questions, you can ask at any time.

If you have additional questions about the study, please contact:

Principal investigator: Nejat Seid (MD, Radiology Resident)
Tel: +251910209360
Email: __nejat.seid@sphmmc.edu.et_____

Are you willing to participate? A. YES B. NO

Annex II: English Version Questionnaire

Questionary format prepared to collect information on LS MR imaging pattern in assessment of the appropriates and factors associated with ordering lumbosacral MRI at St. Paulo's Hospital Millennium Medical College (SPHMMC), Addis Abeba,

Part I. Patient Related Factor

No.	Question	Response
1	Age (years)	
2	Sex	□Female □ Male
3	Duration of lower back pain	□<4 weeks □4-6 weeks □>6 weeks
4	Presence of radiculopathy	□Yes □No
5	History of back injury/ trauma	□Yes □No
6	Neurological deficits	□Yes □No
7	Red flag symptoms	□Yes □No
8	Severity of pain	□Mild □moderate □ severe
9	Previous imaging history	□Non □x ray □CT □ MRI

Part II. Clinical Presentation Factors

No.	Question	Response
10	Lower back pain with radiculopathy	□Yes □No
11	Lower back pain without radiculopathy	□Yes □No

12	Limb pain alone	□Yes □No
13	Suspected disc herination	□Yes □No
14	Suspected infection	□Yes □No
15	Suspected degenerative disease	□Yes □No
16	Suspected scoliosis or kyphosis	□Yes □No

Part III. Provider -Related Factors

No.	Questions	Response
17	Ordering clinicians' specialty	□Orthopedics □Neurosurgery □Neurology □Internal medicine □Emergency. □ others
18	Level of clinician	□intern □General practitioner □Resident □specialist □consultant
19	Documentation quality of MRI Request form	□Good □ poor

Part IV. Diagnostic and imaging Related Factors

No	Question	Response
20	Type of preliminary image	□Non □x ray □CT
21	Clinical indication documented on MRI request form	□Yes □No
22	MRI finding correlate with clinical symptoms	□Yes □No
23	Degenerative changes detected on MRI	□Yes □No
24	Disc bulge/ dis herination detected on MRI	

Part V.ACR Appropriateness Assessment variant (2021)

1) (Variant 1) acute lower back pain with or without radiculopathy, no red flags. no prior management.
2) (variant 2) subacute or chronic lower back pain with or without radiculopathy, no red flags. no prior management
3) (Variant 3) candidate for surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks optimal medical
4) (Variant 4) lower back pain with suspected cauda equine syndrome
5) (Variant 5) New or worsening symptoms or clinical findings after previous lumbar surgery;
6) (Variant 6) lower back pain with or without radiculopathy .one or more of the following low velocity trauma, osteoporosis, elderly individual, or chronic steroid use.
7) (variant 7) suspicions for cancer, infection, or immunosuppression

. If the MRI referrals did not include information on any of the disorders, they would be considered inappropriate (Variant 1). Inappropriate referrals were split into three categories: (1a) no information on prior non-surgical treatment, (1b) no information on the duration of

non-surgical treatment, or (1c) additional causes (e.g., inaccuracies such as missing narrative text, referrals of cervical/thoracic spine

Final Classification
MRI request according to the 2021 ACR Appropriateness Criteria:

☐ Appropriate
☐ Inappropriate

If inappropriate, reason:
☐ No documented clinical indication
☐ No conservative treatment before MRI
☐ Conservative treatment <6 weeks
☐ No red flag symptoms
☐ Incomplete clinical information
☐ Other: _____