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Review

The Spine-Abductor Association: A Conceptual Framework and a Systematic Review of the Literature

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Abstract

Background: Hip abductor tendon tears are commonly associated with age-related degeneration and female sex. However, their frequent coexistence with lumbar spine disease could suggest a potential relationship between these conditions. **Materials and Methods**: A systematic review was conducted in accordance with PRISMA guidelines using PubMed, Embase, and the Cochrane Library to investigate the prevalence of lumbar spine disease among patients with hip abductor tendon pathology, its association with hip abductor morphology and function, and its influence on postoperative outcomes following hip abductor repair. Findings were synthesized narratively according to clinical phenotype and study design. **Results**: Seven studies were included: two observational case–control study, one cross-sectional studies and four monocentric retrospective case series. Included studies encompassed surgical hip abductor repair cohorts, lumbar decompressive surgery cohorts, imaging-based lumbar spine disease cohorts, chronic nonspecific low back pain cohorts, and a large population-level database analysis. Across multiple clinical settings, lumbar spine disease was frequently reported among patients with hip abductor pathology, and imaging and functional studies described reduced gluteus medius morphology or strength in patients with lumbar spine conditions. Population-level data reported an increased incidence of gluteal tendon tears following lumbar spine diagnoses or interventions. **Conclusions**: The main finding of this systematic review is an association between spine conditions and hip abductor pathology. Further prospective studies are required to better define causality and clinical implications.

Keywords: spine; hip; abductors; gluteus medius

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1. Introduction

Hip abductor tendon tears are frequently associated with age-related degeneration, female sex, and elevated body mass index (BMI) [1,2]. However, growing evidence suggests an association between hip abductor pathology and disorders of the lumbar spine and spinopelvic complex [1,2]. Previous studies have reported a high prevalence of concomitant lumbar spine disease among patients with gluteal tendon tears, while population-level analyses have identified increased rates of gluteal tendon tear diagnoses among individuals with lumbar spine conditions [3,4]. This association has also been observed among patients with a history of lumbar corticosteroid injections or surgical interventions [3,4].

Several biomechanical and neuroanatomical mechanisms have been proposed to explain this relationship. Lumbar spine disorders may influence sagittal alignment, compen-

satory movement patterns, and neuromuscular control, potentially affecting pelvic stability and hip abductor function [3,5–8]. Conversely, hip abductor insufficiency may alter pelvic mechanics and increase mechanical demands on the lumbosacral spine [3,5,7,8]. However, the extent to which these potential interactions contribute to structural tendon degeneration or the progression of lumbar spine disease remains uncertain. Thus, improved characterization of this relationship may be clinically relevant. Patients with concurrent lumbar disease may present with atypical symptoms and delayed diagnosis, or diminished response to hip-targeted interventions. Similarly, lumbar-driven neuromuscular dysregulation may impair outcomes following surgical repair of the gluteus medius (GMed)/minimus. A clearer understanding of these interactions may inform counseling and treatment sequencing.

The primary objective of this systematic review was to evaluate the available evidence regarding the association between lumbar spine conditions and hip abductor pathology. Specifically, we aimed to assess the prevalence of concomitant lumbar spine disease among patients with hip abductor tendon pathology, investigate the relationship between lumbar spine conditions and hip abductor morphology and function, and evaluate the potential influence of concurrent lumbar spine disease on postoperative outcomes following hip abductor repair. To address these objectives, the following research questions (RQs) were formulated:

RQ1: What is the prevalence of lumbar spine pathology among patients with hip abductor tendon disease?

RQ2: How does lumbar spine disease influence hip abductor function and clinical presentation?

RQ3: What is the impact of concurrent lumbar spine disease on outcomes after surgical repair of hip abductor tears?

2. Results

2.1. Studies Characteristics

The initial search yielded a total of 268 potentially relevant articles after duplicate removal. After title and abstract selection, 257 articles were excluded. Eleven full-text articles were assessed for eligibility. Four were excluded because they were biomechanical/non in-vivo studies, leaving seven studies for qualitative synthesis [4,9–14]. The study selection process is summarized in Figure 1.

The seven included studies comprised two observational case–control studies [11,14], four retrospective case series [9,10,12,13], and one cross-sectional design studies [4].

Publication years ranged from 2012 to 2024. Key study characteristics and extracted data are presented in Table 1. Given clinical and methodological heterogeneity, studies were interpreted and presented within predefined evidence domains based on phenotype, diagnostic standard, and clinical setting. Findings were not pooled across domains, and inferences were limited to within-domain interpretation.

Table 1. Summary of included studies.

Author	Year	Level of Evidence	Study Design	Patient Characteristics	Outcome of Interest	Follow-Up	Main Findings
Sasaji et al. [10]	2012	4	Monocentric retrospective case series	26 consecutive patients with neurological symptoms of L5 radiculopathy and weakness of hip abductor muscle (10 F: 38.5%; 16 M: 61.5%, mean age 66 years) who underwent lumbar decompressive surgery for lumbar disc herniation (LDH) and lumbar spinal canal stenosis (LSCS) between 2010 and 2011 in a single institute. In LDH and central LSCS, the L4–5 segment was involved. In foraminal LSCS, the L5–S segment was involved.	Hip abductor muscle strength (measured using a manual muscle test and graded on a 0 (paralysis) to 5 (normal strength) arbitrary units scale) scale after lumbar decompressive surgery; postoperative improvement rate (%)	Mean FU 14 months (range 12–22 months)	• Hip abductor strength improvement: 23/26 patients (88%). • Complete recovery: 17/26 patients (65%). • Improvement by diagnosis: LDH 92%; LSCS 68% ($p = 0.054$). • Persistent weakness mainly observed in older male patients with LSCS.
Cooper et al. [14]	2016	3	Observational case–control study	150 subjects with chronic non-specific LBP (97 F: 64.7%, 53 M: 35.3%, 41.4 ± 13.0 years, mean BMI 29.6 ± 7.2) and a matched cohort of 75 control subjects (F 65.3%, M 34.7%, 40.7 ± 13.9 years, mean BMI 25.8 ± 7.0)	Prevalence of hip abductor weakness and tenderness: Manual muscle testing (MMT) of GMed, TFL, and gluteus maximus; Trendelenburg sign; palpation tenderness over gluteal, trochanteric, and lumbar regions	Not applicable (case–control)	• Greater GMed weakness in chronic LBP patients compared with controls ($p < 0.001$). • Higher prevalence of positive Trendelenburg sign ($p < 0.001$). • Increased gluteal, trochanteric, and paraspinal tenderness ($p < 0.001$). • GMed weakness was the strongest predictor of LBP ($\Delta R^2 = 0.46$; $p < 0.001$).

Table 1. *Cont.*

Author	Year	Level of Evidence	Study Design	Patient Characteristics	Outcome of Interest	Follow-Up	Main Findings
Saltzman et al. [9]	2019	4	Monocentric retrospective case series	47 patients initially enrolled; 38 patients included in the final clinical and radiographic analyses (35 F: 92.1%; 3 M: 7.9%;mean age 60.5 ± 10.3, mean BMI 27.2 ± 5.3.) who underwent GMed or minimus repair with a single, fellowship-trained surgeon between 20 January 2012, and 25 November 2015 and agreed to be radiographically evaluated with a scoliosis series	38 patients (32 endoscopic, 6 open) pre- and post-operative Hip Outcome Score—Activities of Daily Living (HOS-ADL), Hip Outcome Score—Sports Subscale (HOS-SS), modified Harris Hip Score (mHHS), Visual Analog Scale (VAS) Pain, Short Forme12 Physical, and International Hip Outcome Tool (iHOT)-12; spinopelvic parameters (sagittal vertical axis: SVA, Cobb angle)	Mean 28.2 ± 7.8 months (range 22–51 months); radiographic follow-up mean 37.4 ± 15.1 months	• Scoliosis prevalence: 18/38 patients (47%). • Significant postoperative improvement in all PROs and pain scores ($p < 0.001$). • Greater SVA associated with worse HOS-ADL (r = −0.405; $p = 0.026$) and HOS-SS (r = −0.492; $p = 0.011$). • Positive sagittal imbalance (SVA > 0 cm) associated with worse HOS-SS ($p = 0.04$). • Patients with scoliosis had worse postoperative iHOT-12 scores ($p = 0.043$).
Chong et al. [11]	2023	4	Matched case–control study	LSCS symptoms and unilateral buttock pain group: 48 patients (57.8 ± 9.84 years; 29 F: 60.4%; 19 M: 39.6%; mean BMI 24.26; mean disease duration was 14.0 months; MRI-confirmed LSS: segment involved was L3/4 in 7 cases, L4/5 in 36 patients, L5/1 in 5 cases; exclusion of hip OA, prior lumbar/hip surgery, systemic disease); Non-LSS group: 48 patients (56.42 years; 29 F: 60.4%; 19 M: 39.6%; mean BMI 24.12)	Both sides GMed cross-sectional area (CSA) on T2-weighted MRI images; correlation between patient characteristics, clinical evaluation (Visual Analog Scale and Oswestry Disability Index), and radiological measurement data with a decrease in the CSA of GMed were assessed in the LSS group	Not applicable	• Ipsilateral GMed atrophy in 81% of LSCS patients. • Smaller GMed CSA on the symptomatic versus asymptomatic side ($p < 0.05$). • Greater GMed CSA asymmetry in LSCS patients versus controls ($p < 0.01$). • GMed atrophy correlated with buttock pain VAS (r = 0.445; $p = 0.002$) and ODI (r = 0.324; $p = 0.025$). • Buttock pain VAS explained 19.8% of the variance in GMed atrophy ($R^2 = 0.198$).

Table 1. *Cont.*

Author	Year	Level of Evidence	Study Design	Patient Characteristics	Outcome of Interest	Follow-Up	Main Findings
Paul et al. [12]	2024	4	Monocentric retrospective case series	23 hips (22 patients) (20 F: 86.9%; 3 M: 13.1%, 63.6 ± 9.1 years, mean BMI 30.6 ± 5.4) who underwent endoscopic GMed repair by a single fellowship trained surgeon between May 2016 and May 2020	Outcomes between patients with and without a history of lumbar pathology; lumbar pathology diagnosis was made based on history of symptoms, imaging, and surgical history (lumbar pathology symptoms greater than 6 months or they had spine surgery to address lumbar pathology)	Mean 2.3 ± 1.0 years (range 0.5–5 years)	• History of lumbar pathology: 19/23 cases (82.6%). • Degenerative disc disease: 17/19 (89.5%). • Spinal stenosis: 12/19 (63.2%). • Similar postoperative iHOT-12 scores in patients with and without lumbar pathology. • Lower postoperative HOS-ADL scores in patients with lumbar pathology, without statistical significance.
Uppstrom et al. [13]	2024	4	Monocentric retrospective case series	131 cases (130 patients) of primary hip abductor tendon repairs at a tertiary care center between January 2010 and December 2021 (105 F: 80.2%; 26 M: 9.8%; 64 ± 12 years, mean BMI 27.1 ± 4.9). 19% underwent gluteus maximus transfer; 13 patients had concomitant THA	Prevalence of L4 to S1 lumbo-sacral spine disease in a sample of patients undergoing primary hip abductor tendon repair (confirmed L4 to S1 disease based on L4 to S1 interventions, including decompression surgery or therapeutic epidural injections, and/or confirmed electromyography evidence of L4 to S1 radiculopathy; radiographic evidence of L4 to S1 disease based on dedicated lumbar spine MRI demonstrating central or foraminal nerve compression at L4 to S1)	Not specified (cross-sectional analysis of retrospective cohort)	• Confirmed L4–S1 pathology: 29%; radiographic-only pathology: 12%; no pathology: 59%. • Patients with L4–S1 pathology were older (67 vs. 61 years; $p = 0.004$). • Higher proportion of male patients with L4–S1 pathology (38.5% vs. 16.7%; $p = 0.06$). • No significant differences in BMI, injury mechanism, concomitant THA, or gluteus maximus transfer. • L4–S1 pathology in 54% of patients undergoing concomitant THA and abductor repair.

Table 1. *Cont.*

Author	Year	Level of Evidence	Study Design	Patient Characteristics	Outcome of Interest	Follow-Up	Main Findings
Lavu et al. [4]	2024	4	Cross-sectional	>85 million EHR records from 59 U.S. healthcare organizations; 8,475,800 patients who had received lumbar spine diagnoses, undergone lumbar injections, and/or undergone lumbar surgeries from the U.S. 764,235 patients with gluteal tears (mean age 63 ± 17 yrs; 527,153 F: 69%; 237,082 M: 31%; 27% obese) overlap group of 458,311 patients (60% of all gluteal tear cases) with both lumbar spine disease and gluteal tears (Low back pain 6.2%; Radiculopathy 10.4%; Myelopathy 11.1%; intervertebral disc disorders 9.0%; Spondylopathies 8.4%; Deformity 11.4%)	Overlap between lumbar spine disease and gluteal tears; relative risks of gluteal tears among populations who received lumbar spine diagnoses, injections, and/or surgery (discectomy; laminectomy/laminotomy; fusion; vertebral augmentation; osteotomy; instrumentation); rates of gluteal tear-free survival between patients with and without lumbar spine disease diagnoses and/or treatments	Approx. 13 years (2010–2023)	• Gluteal tears in 458,311/8,475,800 patients with lumbar spine disease (5.4%). • Strong association between lumbar spine disease and gluteal tears (RR = 13.6; 95% CI 13.6–13.6). • Highest relative risk in lumbar radiculopathy (RR = 15.4). • Increased risk associated with lumbar injections (RR = 13.1) and lumbar surgery (RR = 9.0). • After matching: higher cumulative incidence of gluteal tears in patients with lumbar spine diagnoses (4.2% vs. 0.8%; HR = 4.8; 95% CI 4.5–5.1).

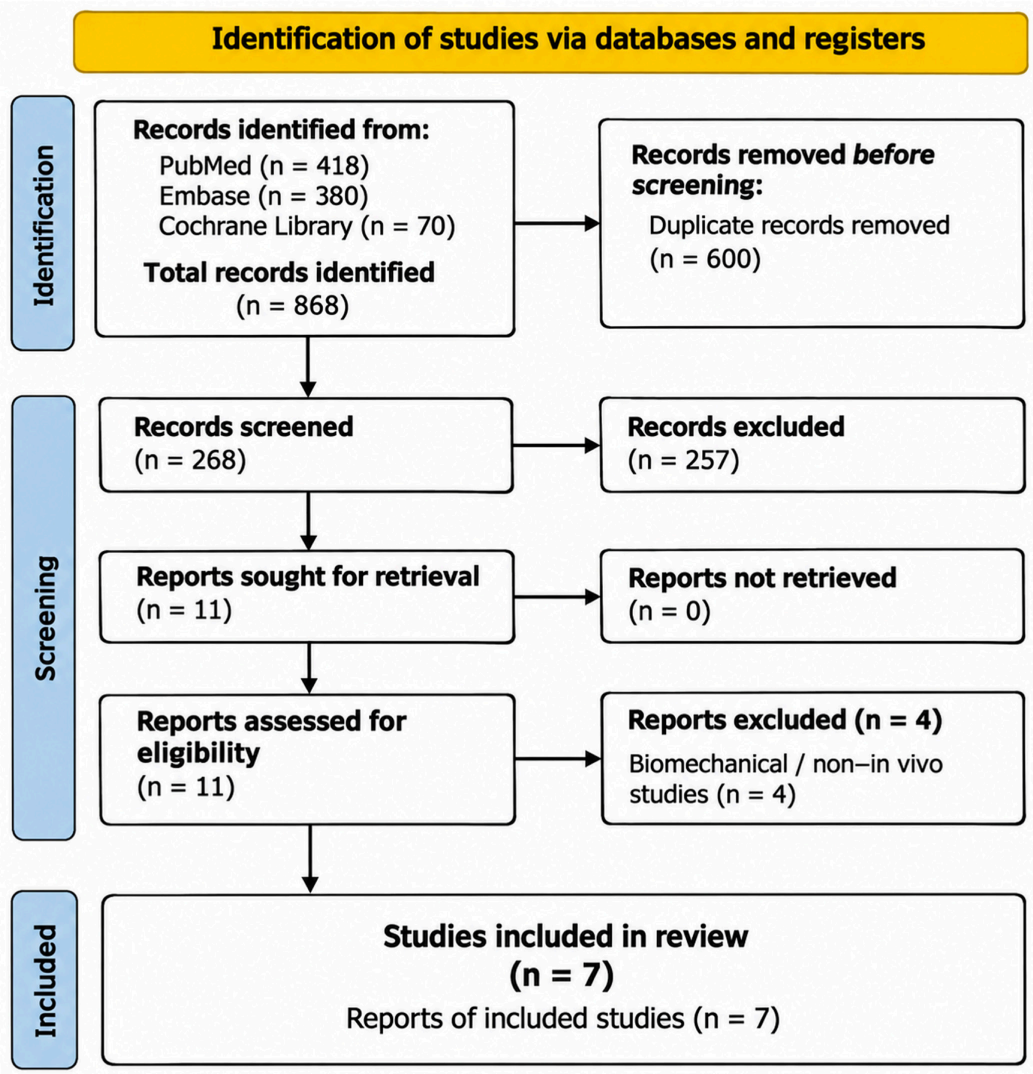

Figure 1. Flowchart of the selection process according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines.

2.2. Hip Abductors Surgical Repair Cohorts

Three studies [9,12,13] investigated lumbar spine pathology in patients undergoing hip abductor tendon repair. These studies included 201 surgical cases in the original cohorts, of which 192 were included in the reported analyses. Specifically, Saltzman et al. included 38 of 47 initially enrolled patients, Paul et al. analyzed 23 patients, and Uppstrom et al. reported 131 surgical cases involving 130 individual patients. Among the 192 analyzed cases, 160 (83.3%) were female and 32 (16.7%) were male, with a weighted mean age of 62.6 years.

Uppstrom et al. conducted a retrospective case series evaluating L4–S1 pathology prevalence among 131 surgical cases involving 130 individual patients undergoing GMed repair. L4–S1 pathology was defined as prior L4–S1 decompressive surgery or epidural injections, or electromyography-verified radiculopathy. They reported that among patients undergoing isolated GMed repair, 29.0% had confirmed L4–S1 pathology, and an additional 12.2% showed central or foraminal L4–S1 nerve compression on lumbar MRI. Among patients undergoing combined GMed repair and total hip arthroplasty, 46.2% had confirmed L4–S1 pathology, while 7.6% showed MRI evidence of L4–S1 involvement [13].

Paul et al. conducted a retrospective case series evaluating the prevalence of lumbar pathology and postoperative outcomes following GMed repair in 23 surgical cases involving 22 individual patients [12]. They reported prior lumbar interventions in 73.0% of patients, including epidural injections (21.7%), laminectomy (34.8%), and spinal fusion (30.4%), with some patients receiving multiple procedures [14]. Postoperative iHOT-12 scores were comparable between patients with and without lumbar spine disease, whereas HOS–Activities of Daily Living scores were lower in patients with lumbar spine disease, although this difference did not reach statistical significance.

Saltzman et al. performed a retrospective case series assessing patient-reported outcomes in a consecutive cohort of patients undergoing gluteus medius repair. Patients were assessed with dedicated scoliosis radiographs evaluating sagittal balance (SVA) and Cobb angle [9]. They reported significant improvement in PROs after GMed repair ($p < 0.001$), but patients with positive sagittal balance (SVA > 0 cm) or scoliosis (Cobb angle >10°) had significantly worse postoperative outcomes [9].

2.3. Lumbar Decompressive Surgery Cohorts

Sasaji et al. assessed GMed weakness by manual muscle testing in 26 consecutive patients before and after lumbar decompressive surgery for L5 radiculopathy due to lumbar disc herniation (LDH) or central/foraminal stenosis [10]. They reported that GMed weakness assessed by manual muscle testing improved in 88% of patients following lumbar decompressive surgery, with complete recovery observed in 65% of cases [10].

2.4. Imaging-Based Lumbar Spine Disease Cohorts

Chong et al. case–control study compared GMed morphology on T2-weighted MRI in 48 patients with LSCS and unilateral buttock pain versus 48 matched controls [11]. They found reduced GMed cross-sectional area (CSA) on the symptomatic side in 81% of lumbar spine stenosis patients [11].

2.5. Chronic Nonspecific Low Back Pain Cohorts

Cooper et al. case–control study compared 150 subjects with chronic non-specific LBP defined as pain anywhere from the inferior rib margin to the gluteal fold for more than 3 months) with a matched cohort of 75 control subjects [14]. They reported that individuals with chronic nonspecific low back pain had significantly weaker GMed strength on manual muscle testing, more frequent Trendelenburg sign, and greater tenderness over the gluteals, greater trochanter, and paraspinals compared with matched controls ($p < 0.001$) [14].

2.6. Population-Level Database Analyses

In a large population-based analysis using administrative diagnostic codes from the U.S., Lavu et al. assessed gluteal tear prevalence in patients who received lumbar spine diagnoses or underwent lumbar injections and/or lumbar surgeries [4]. Among 8,475,800 patients with a history of lumbar spine disease, lumbar injections, and/or lumbar surgery, 458,311 (5.4%) had a diagnosis of gluteal tendon tears, corresponding to a relative risk of 13.6 (95% CI: 13.6–13.6). After adjustment for age, sex, and obesity, survival analysis over a 13-year period (2010–2023) identified increased hazards of subsequent gluteal tendon tear diagnosis among patients with a previous lumbar spine diagnosis (HR: 4.8; 95% CI: 4.5–5.1), lumbar injections (HR: 7.7; 95% CI: 6.2–9.5), or lumbar surgery (HR: 6.6; 95% CI: 5.3–8.1) recorded in 2010.

2.7. Risk of Bias

Quality assessment was performed using the Newcastle–Ottawa Scale and the Joanna Briggs Institute (JBI) Critical Appraisal Checklists, with tools selected according to study design. Although most studies fulfilled several methodological appraisal criteria, important limitations remained across the included evidence. Regarding the prevalence of concomitant lumbar spine disease among patients with hip abductor tendon pathology, heterogeneous diagnostic criteria and selected surgical populations introduced potential selection and classification biases, thereby limiting the generalizability of prevalence estimates [4,12,13]. Studies investigating hip abductor morphology and function were predominantly cross-sectional or observational, limiting the assessment of temporal relationships and the ability to distinguish neurological muscle dysfunction from structural tendon injury [10,12,14]. Furthermore, studies evaluating postoperative outcomes following hip abductor repair were limited by relatively small sample sizes, retrospective designs, heterogeneous spinal conditions, and incomplete control of potential confounders [9,12]. The population-level database study was additionally subject to potential diagnostic misclassification due to reliance on administrative codes without systematic imaging confirmation [4]. Consequently, favorable checklist scores did not necessarily indicate a low overall risk of bias, and confidence in individual findings was limited by these study-specific methodological considerations. The results of the quality assessment are summarized in Tables 2–6.

Table 2. Adapted version of the Newcastle–Ottawa Scale quality assessment scale (NOS) for cross-sectional studies, as proposed by Modesti et al. (★ = 1 point; ★★ = 2 points according to the Newcastle–Ottawa Scale scoring system).

Study	Selection: Representativeness of the Sample (Max: 1 Star)	Selection: Sample Size Justification (Max: 1 Star)	Selection: Non-Respondents (Max: 1 Star)	Selection: Ascertainment of the Exposure (Max:1 Star)	Comparability: (Max: 2 Stars)	Outcome: Assessment of Outcome (Max: 1 Stars)	Outcome: Statistical Test (Max: 1 Star)	Outcome: Reporting Completeness (Max: 1 Star)	Total Stars (Max: 9 Stars)
Lavu et al., 2024 [4]	1	1	1	1	2	1	1	1	9

Methodological Notes: Lavu et al. [4] conducted a multicenter electronic health record-based analysis using ICD/CPT diagnostic codes, propensity score matching, and Cox regression models. Relevant confounders, including age, sex, and BMI, were accounted for. The main limitation was the lack of individual case-level verification.

Table 3. Newcastle–Ottawa Scale quality assessment scale (NOS) for case–control studies (★ = 1 point; ★★ = 2 points according to the Newcastle–Ottawa Scale scoring system).

Study	Selection: Adequate Case Definition (Max: 1 Star)	Selection: Representativeness of Cases (Max: 1 Star)	Selection: Selection of Controls (Max: 1 Star)	Selection: Definition of Controls (Max:1 Star)	Comparability: (Max: 2 Stars)	Exposure: Ascertainment of Exposure (Max: 1 Stars)	Exposure: Same Method of Ascertainment (Max: 1 Star)	Exposure: Non-Response Rate (Max: 1 Star)	Total Stars (Max:9 Stars)
Chong et al., 2023 [11]	1	1	1	1	2	1	1	1	9

Table 3. *Cont.*

Study	Selection: Adequate Case Definition (Max: 1 Star)	Selection: Representativeness of Cases (Max: 1 Star)	Selection: Selection of Controls (Max: 1 Star)	Selection: Definition of Controls (Max:1 Star)	Comparability: (Max: 2 Stars)	Exposure: Ascertainment of Exposure (Max: 1 Stars)	Exposure: Same Method of Ascertainment (Max: 1 Star)	Exposure: Non-Response Rate (Max: 1 Star)	Total Stars (Max:9 Stars)
Cooper et al., 2016 [14]	1	1	1	1	2	1	1	1	9

Methodological notes: Chong et al. [11]: Hospital-based matched case–control study with cases defined using clinical and imaging criteria. Controls were selected from an outpatient MRI population rather than the general community. Age- and sex-matching was performed, with additional confounders addressed through multivariable analysis. Gluteus medius cross-sectional area (CSA) was assessed using standardized and blinded MRI measurements. The main limitation was the cross-sectional nature of the assessment, which precludes establishing temporal or causal relationships, Cooper et al. [14]: Case–control study involving patients with chronic nonspecific low back pain (>3 months), consecutively recruited from a specialized outpatient clinic, and age- and sex-matched controls. Specific spinal pathologies were excluded, and additional demographic differences, including BMI, were addressed through multivariable regression. Standardized clinical examinations were performed using identical protocols. Inter-rater reliability was excellent for the Trendelenburg sign and tenderness assessments, but moderate for manual muscle testing. The main limitation was the inability to establish temporal relationships between hip abductor weakness and low back pain.

Table 4. JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies.

JBI CRITICAL APPRAISAL CHECKLIST FOR CROSS-SECTIONAL STUDIES	Lavu [4]
Were the criteria for inclusion in the sample clearly defined?	YES
Were the study subjects and the setting described in detail?	YES
Was the exposure measured in a valid and reliable way?	YES
Were objective, standard criteria used for measurement of the condition?	YES
Were confounding factors identified?	YES
Were strategies to deal with confounding factors stated?	YES
Were the outcomes measured in a valid and reliable way?	YES
Was appropriate statistical analysis used?	YES

Table 5. JBI Critical Appraisal Checklist for Case Series.

JBI CRITICAL APPRAISAL CHECKLIST FOR CASE SERIES	Uppstrom [13]	Sasaji [10]	Saltzman [9]	Paul [12]
Were there clear criteria for inclusion in the case series?	YES	YES	YES	YES
Was the condition measured in a standard, reliable way for all the participants included in the case series?	YES	YES	YES	YES
Were valid methods used for the identification of the condition for all participants included in the case series?	YES	YES	YES	YES

Table 5. *Cont.*

JBI CRITICAL APPRAISAL CHECKLIST FOR CASE SERIES	Uppstrom [13]	Sasaji [10]	Saltzman [9]	Paul [12]
Did the case series have consecutive inclusion of participants?	YES	YES	YES	UNCLEAR
Was there clear reporting of the demographics of the participants in the study?	YES	YES	YES	YES
Was there clear reporting of clinical information of the participants?	YES	YES	YES	YES
Were the outcomes or follow up results of cases clearly reported	YES	YES	YES	YES
Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	YES	NO	NO	NO
Was statistical analysis appropriate?	YES	YES	YES	YES

Table 6. JBI Critical Appraisal Checklist for Case–Control Study.

JBI CRITICAL APPRAISAL CHECKLIST FOR CASE–CONTROL STUDIES	Chong [11]	Cooper [14]
Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?	YES	YES
Were cases and controls matched appropriately?	YES	YES
Were the same criteria used for identification of cases and controls?	YES	YES
Was exposure measured in a standard, valid, and reliable way?	YES	UNCLEAR
Was exposure measured in the same way for cases and controls?	YES	YES
Were confounding factors identified?	YES	YES
Were strategies to deal with confounding factors stated?	YES	YES
Were outcomes assessed in a standard, valid, and reliable way?	YES	YES
Was the exposure period of interest long enough to be meaningful?	UNCLEAR	NO
Was appropriate statistical analysis used?	YES	YES

3. Discussion

This systematic review synthesizes the available evidence on the relationship between lumbar spine disease and hip abductor pathology across multiple clinical contexts. Collectively, the included studies suggest a coexistence of these conditions, herein referred to as the spine–abductor association. This term is used as a descriptive and conceptual framework rather than a diagnostic or causal entity. The body of evidence is predominantly observational, thereby precluding causal inference. Accordingly, findings should be interpreted as hypothesis-generating, and conclusions are restricted to within-domain

associations. Since the overall certainty of evidence remains low, further prospective studies are required to better define causality and clinical impact.

Across surgical, imaging-based, and population-level cohorts, lumbar spine disease was frequently reported among patients with hip abductor pathology. Age- and sex-related factors may represent shared demographic contributors to the observed association. Hip abductor tears were more commonly observed in older individuals and females, a demographic pattern shared with degenerative lumbar spine conditions [15]. In a large population-based analysis, patients with gluteus medius tears were significantly older than those without tears, and females accounted for a greater proportion of the affected cohort [4].

Several studies reported a high prevalence of lumbar spine disease among patients undergoing hip abductor repair. In population-level data, a substantial proportion of patients diagnosed with gluteal tendon tears had a documented history of lumbar spine disease [4]. Single-institution surgical cohorts similarly reported frequent coexistence of lumbar pathology among patients treated for gluteus medius tears, including prior lumbar interventions and MRI evidence of lumbosacral disease [12,13]. Although prevalence estimates varied according to diagnostic criteria and study design, these findings were consistently reported across distinct clinical settings.

Spinal alignment and lumbar disease were suggested to influence outcomes following hip abductor repair. However, findings regarding the influence of concomitant lumbar spine disease on postoperative outcomes following hip abductor repair were inconsistent. Paul et al. [12] did not find statistically significant differences in postoperative scores between patients with and without lumbar spine disease. Conversely, Saltzman et al. [9] reported significantly worse postoperative outcomes among patients with sagittal imbalance or coronal plane deformity, despite overall improvements following gluteus medius repair. These differences may reflect heterogeneity in lumbar spine conditions and spinal alignment parameters, surgical populations, and outcome measures. Moreover, the small sample sizes and retrospective designs limit definitive conclusions regarding the independent influence of lumbar spine disease on outcomes following hip abductor repair.

Functional and imaging-based studies further described alterations in hip abductor morphology and performance across different lumbar spine-related clinical populations. Imaging studies reported reduced gluteus medius cross-sectional area in patients with lumbar spinal canal stenosis [11], whereas a case–control study of chronic nonspecific low back pain identified reduced hip abductor strength, a higher prevalence of a positive Trendelenburg sign, and increased tenderness compared with matched controls [14]. However, chronic nonspecific low back pain does not necessarily indicate structural lumbar spine disease, and neither reduced muscle cross-sectional area nor impaired abductor function establishes the presence of tendon injury. These findings should therefore be interpreted as evidence of morphological and functional associations rather than structural tendon pathology or causal relationships.

Several biomechanical mechanisms have been proposed to contextualize the observed associations, although these remain hypothetical and were not directly investigated by the studies included in this systematic review. Altered lumbar mobility associated with degenerative changes or previous spinal surgery may influence spinopelvic alignment and hip biomechanics [16]. These alterations have been proposed to contribute to femoroacetabular and ischiofemoral impingement [17–19]. Furthermore, age-related sagittal imbalance may modify femoral positioning and increase mechanical demands on the anterior gluteal fibers, where tendon tears frequently occur [20]. Collectively, these proposed alterations in hip biomechanics could contribute to increased abductor loading and tendon degeneration.

However, these pathways remain speculative, and their potential contribution to structural tendon injury requires further prospective biomechanical and clinical investigation.

Neuroanatomical mechanisms may also contribute to the observed association. Compression of the L4–S1 nerve roots, which contribute to the superior gluteal nerve, may result in gluteus medius weakness or atrophy [21,22]. Electromyographic and imaging studies reporting altered muscle activation patterns and reduced muscle bulk among patients with lumbar spine disease are consistent with a potential neurological contribution to hip abductor dysfunction [23]. Similarly, improvements in hip abductor strength following lumbar decompressive surgery suggest a possible neurological component of muscle weakness [10]. However, these findings concern muscle function and morphology rather than structural tendon integrity.

Altered gait mechanics may represent an additional potential pathway linking lumbar spine conditions and hip abductor dysfunction. Neurogenic claudication and radiculopathy may be accompanied by compensatory gait patterns, potentially modifying mechanical demands on the hip abductors [24–26]. Similarly, coronal plane deformities such as scoliosis may contribute to asymmetric loading, although their direct effects on hip abductor tendon integrity remain uncertain [23,27,28]. Altered gluteus medius activation patterns during gait have also been reported among patients with scoliosis [29]. Nevertheless, whether these functional and biomechanical adaptations contribute to tendon overload or degeneration has not been established and requires further prospective investigation.

From a clinical perspective, the observed coexistence of lumbar spine conditions and hip abductor dysfunction highlights the importance of considering both conditions during clinical evaluation, particularly in patients presenting with gait abnormalities or a history of lumbar spine disease. Recognition of concomitant pathology may be relevant to patient counseling and decisions regarding surgical timing. However, the available evidence does not establish whether specific diagnostic strategies or treatment sequences improve clinical outcomes. This systematic review has several limitations. First, the absence of specific search terms related to gluteal tendon pathology, greater trochanteric pain syndrome, sagittal imbalance, and spinal deformity may have reduced search sensitivity and resulted in the omission of potentially relevant studies. Second, the available evidence was predominantly derived from level IV studies, with some level III evidence from observational case–control studies. The predominance of retrospective and uncontrolled study designs inherently limits causal inference. Plus, several studies involved relatively small sample sizes, heterogeneous inclusion criteria, and selected clinical populations, potentially introducing selection bias and limiting generalizability. Furthermore, considerable heterogeneity existed in the definitions of both lumbar spine conditions and hip abductor pathology. In particular, structural tendon lesions, muscle weakness, atrophy, and functional impairment were investigated across different studies, although these findings represent distinct clinical entities. Similarly, lumbar spine involvement was variably defined through clinical history, imaging findings, previous interventions, or nonspecific low back pain, limiting comparability across populations. Diagnostic modalities and imaging protocols were also heterogeneous, with inconsistent assessment of muscle morphology and tendon integrity. Moreover, several studies did not adequately control for potential confounding factors. The predominantly cross-sectional and retrospective nature of the evidence further limits the assessment of temporal relationships between lumbar spine conditions and hip abductor pathology. Regarding surgical outcomes, variability in operative techniques, incomplete preoperative data, heterogeneous patient-reported outcome measures, and differences in follow-up duration limited direct comparisons and precluded quantitative synthesis. Population-level database analyses were additionally subject to potential diagnostic misclassification and incomplete clinical characterization, particularly because tendon injuries identified through

administrative codes were not systematically confirmed by imaging. Finally, although the Newcastle–Ottawa Scale and Joanna Briggs Institute critical appraisal tools yielded generally favorable assessments, these findings should be interpreted cautiously, as fulfillment of individual methodological criteria does not overcome the limitations inherent to retrospective and uncontrolled studies. Overall, these methodological considerations limit the strength of the available evidence and preclude definitive conclusions regarding causality and the influence of concomitant lumbar spine conditions on surgical outcomes.

4. Materials and Methods

4.1. Protocol and Registration

This systematic review was conducted in accordance with 2020 PRISMA guidelines. The protocol was registered in PROSPERO (CRD420251184800).

4.2. Search Strategy and Selection Process

A systematic literature search was conducted in PubMed/MEDLINE, Embase, and the Cochrane Library, with the last search performed in April 2025. The search strategy combined free-text terms related to hip abductor pathology and lumbar spine conditions using Boolean operators (AND, OR). Grey literature sources or preprint servers were not searched, because they may introduce publication bias by potentially excluding relevant unpublished or non-peer-reviewed studies. A representative PubMed search string was: ((hip abductor OR gluteus medius OR gluteus minimus OR abductor tendon OR gluteal tendon) AND (lumbar spine OR lumbosacral OR spine OR lumbar disease OR lumbar stenosis OR lumbar radiculopathy)). Full database-specific search strategies are detailed in Appendix A. The search strategy was peer-reviewed using the PRESS checklist. After removal of duplicates, two reviewers (M.M. and B.D.M.) independently screened all titles and abstracts for eligibility. Full texts of potentially relevant studies were then assessed independently. Prior to the screening process, a calibration exercise was conducted on a subset of studies. Inter-rater agreement between reviewers was assessed using Cohen's kappa coefficient, demonstrating substantial agreement ($\kappa = 0.87$). Discrepancies during screening or data extraction were resolved through discussion or consultation with a third reviewer (E.K.). No automation tools were used in the screening process.

4.3. Eligibility Criteria

Eligible studies included adults (≥18 years) with hip abductor pathology and/or lumbar spine disease. Eligible studies were considered according to the specific hip abductor condition investigated, distinguishing structural tendon pathology (tears or tendinopathy) from muscle dysfunction (weakness, atrophy, or functional impairment). Similarly, lumbar spine conditions were differentiated according to their clinical presentation and diagnostic characterization. These conditions were not considered interchangeable, and findings were synthesized accordingly. Studies were required to evaluate the association between hip abductor and lumbar spine pathology, including prevalence, functional or surgical outcomes. Studies considered were randomized controlled trials, prospective and retrospective cohort studies, case–control studies, and case series with ten or more patients. Only studies published in English were included. No date restrictions were applied during the literature search; all studies published up to the 15 April 2025 were considered for inclusion regardless of publication year.

4.4. Data Collection Process

Data extraction was performed independently by two reviewers (M.M. and B.D.M.) using a standardized form. Extracted information included study characteristics, participant

demographics, diagnostic criteria, interventions, and reported outcomes. Disagreements were resolved by consensus.

4.5. Data Items

Data items included: study design and sample size; patient demographics (age, sex, BMI); diagnostic methods for hip abductor and lumbar pathology; pre- and postoperative findings; patient-reported outcome measures (PROs); imaging or biomechanical results; and surgical outcomes when applicable.

4.6. Risk of Bias Assessment

Risk of bias was assessed independently by two reviewers (M.M. and V.L.). For observational studies, the Newcastle-Ottawa Scale (NOS) was used to evaluate selection, comparability, and outcome domains. For cross-sectional studies, an adapted version of the Newcastle–Ottawa Scale (NOS), as proposed by Modesti et al. [30] was used. In addition, the Joanna Briggs Institute (JBI) critical appraisal checklists were used for case series and cross-sectional studies [31], providing a complement ary assessment tailored to their methodological characteristics. Appraisal findings were interpreted considering individual methodological domains and the limitations inherent to each study design, rather than relying exclusively on numerical quality scores. Agreement between reviewers was excellent (Cohen's $\kappa = 0.92$), and disagreements were resolved by consensus. No automation tools were used.

4.7. Effect Measures

For studies reporting quantitative associations, effect measures such as risk ratios, odds ratios, and mean differences were extracted or recorded when available.

4.8. Synthesis Methods

Due to heterogeneity in study design, populations, and outcomes, results were synthesized using a structured narrative approach. Findings were interpreted according to study design. No causal inferences were drawn across designs. Given variability across studies, outcome definitions were recorded as reported by the original authors. Hip abductor tears were defined based on imaging (MRI or ultrasound), intraoperative findings, or surgical indication, depending on study design. Lumbar spine involvement encompassed a range of definitions, including documented lumbar diagnoses, imaging evidence of central or foraminal stenosis, electromyography-confirmed radiculopathy, or history of lumbar interventions (e.g., injections or surgery). Radiculopathy was defined as clinically diagnosed nerve root involvement confirmed by imaging or electromyography when available. Due to heterogeneity in definitions, prevalence and association estimates were interpreted descriptively rather than quantitatively pooled.

5. Conclusions

The available literature suggests that lumbar spine conditions frequently coexist with hip abductor tendon pathology, although prevalence estimates vary across clinical populations and diagnostic criteria. Furthermore, lumbar spine conditions have been associated with alterations in hip abductor morphology and function, but a direct relationship with structural tendon injury has not been established. Evidence regarding the influence of concomitant lumbar spine disease on outcomes following hip abductor repair remains limited and inconsistent. Overall, these findings support an association between lumbar spine conditions and different aspects of hip abductor pathology, although causal relationships re-

main uncertain. Further prospective studies are warranted to clarify these relationships and their implications for clinical evaluation, patient counseling, and surgical decision-making.

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Appendix A

Pubmed:

((“hip abductor”[Title/Abstract] OR “hip abductors”[Title/Abstract] OR “gluteus medius”[Title/Abstract] OR “gluteus minimus”[Title/Abstract] OR “abductor tendon*”[Title/Abstract] OR “gluteal tendon*”[Title/Abstract])
AND
(“lumbar spine”[Title/Abstract] OR spine[Title/Abstract] OR lumbosacral[Title/Abstract] OR “lumbar disease”[Title/Abstract] OR “lumbar stenosis”[Title/Abstract] OR “lumbar radiculopathy”[Title/Abstract]))

Embase:

(‘hip abductor*’:ti,ab OR ‘gluteus medius’:ti,ab OR ‘gluteus minimus’:ti,ab OR ‘abductor tendon*’:ti,ab OR ‘gluteal tendon*’:ti,ab)
AND
(‘lumbar spine’:ti,ab OR spine:ti,ab OR lumbosacral:ti,ab OR ‘lumbar disease’:ti,ab OR ‘lumbar stenosis’:ti,ab OR ‘lumbar radiculopathy’:ti,ab)

Cochrane Library:

((“hip abductor*” OR “gluteus medius” OR “gluteus minimus” OR “abductor tendon*” OR “gluteal tendon*”)
AND
(“lumbar spine” OR spine OR lumbosacral OR “lumbar disease” OR “lumbar stenosis” OR “lumbar radiculopathy”))

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