

A STUDY ON THE RELATIONSHIP BETWEEN PARASPINAL MUSCLE SIZE IN MRI AND CHRONIC LOW BACK PAIN

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ABSTRACT

A common musculoskeletal disorder linked to functional impairment and changes in lumbar muscle architecture is chronic low back pain (CLBP). This study investigated the relationship between functional impairment in individuals with CLBP and the cross-sectional area (CSA) of the psoas major muscles, multifidus, and erector spinae as determined by magnetic resonance imaging (MRI). 36 patients participated in a prospective, observational, cross-sectional study. Axial T2-weighted MRI at the L3 and L5 vertebral levels was used to quantify bilateral muscular CSA. Functional disability was considered using the Oswestry Disability Index (ODI), and Pearson's correlation analysis examined associations between muscle CSA, bilateral asymmetry, ODI scores, and body mass index (BMI). The average ODI raw score was 22.42 ± 6.58 , and the average participant age was 42.39 ± 13.05 years. Psoas major CSA showed strong negative associations with BMI ($r = -0.440$, $p = 0.007$) and ODI ($r = -0.520$, $p = 0.001$). On the other hand, there were no statistically significant correlations between multifidus and erector spinae CSA and functional impairment. Additionally, there was no correlation between bilateral muscle asymmetry and ODI scores. These results imply that the psoas major CSA may be useful as an imaging-derived morphological indication because it is linked to increased functional impairment in CLBP patients. To determine its therapeutic and prognostic usefulness, larger longitudinal studies are necessary.

KEYWORDS: Oswestry Disability Index; Psoas Major; Paraspinal Muscles; Cross-Sectional Area; Magnetic Resonance Imaging; Chronic Low Back Pain

1. INTRODUCTION

A major musculoskeletal disease burden that affects people all over the world, low back pain (LBP) results in severe functional impairment, low quality of life, and economic hardship. has pain between the gluteal folds and lower rib borders, and it may or may not radiate to the lower limbs. According to the GBD 2021 Low Back Pain Collaborators (2023), 619 million individuals globally suffered from LBP in 2020, and by 2050, that number will increase to 843 million. Because CLBP, which is outlined as pain that lasts longer than 12 weeks, has intricate pathophysiological causes, it tends to be very challenging to treat. Vlaeyen et al. (2018) defined CLBP to be “a complex disorder with biological, psychological and social dimension, affecting the persistence of pain and disability.” Additionally, Hartvigsen et al. (2018) highlighted its significant impacts on health care use, work productivity and quality of life. Therefore, a knowledge of anatomic features related to functional impairments is crucial for better clinical assessment and selection of management. The stability of the lumbar spine relies on the coordination between peaceful spinal structures, muscles and neuromuscular control mechanisms. Panjabi (1992) demonstrated that these interdependent systems work together to provide mechanical stability when moving and loading. Multifidus is one of the lumbar muscles, which is unique in its fascicular arrangement and innervation and is important in segmental stabilisation. Macintosh et al. (1986) noted the intersegmental support properties of the multifidus are related to its anatomical features. The erector spinae muscle is mainly involved in the extension of the trunk and the control of posture while the psoas major is involved in hip flexions, alignment of the lumbar spine and load transmission. Ward et al. (2009) also showed that the organisation of the multifidus in the spine correlates with the multifidus' unique function in the control of lumbar stability. Changes in the structure of these muscles can thus affect spinal biomechanics and be a factor for functional restrictions in people who have long-lasting symptoms of low back pain.

Literature reports that patients with LBP exhibit morphological abnormalities within the lumbar musculature, such as a decrease in CSA, fatty infiltration and bilateral asymmetry. Patients with acute and subacute LBP showed ipsilateral muscle wasting of the multifidus muscle, indicating that muscle changes may occur in early stages of LBP (Hides et al., 1994). Later, Hides et al. (1996) found that recovery of multifidus muscle is not always spontaneous after the symptoms have been resolved. Using MRI, Parkkola et al. (1993) were able to differentiate patients with CLBP from healthy people based on morphological differences in lumbar muscles. Likewise, Danneels et al. (2000) reported changes in the morphology of trunk muscles, with the aid of computed tomography. Together, these studies suggest that structural abnormalities may occur in the lumbar spine with persistent pain, but their connections with disability are not fully understood.

Studies that have watched at specific groups of muscles in the lumbar area have been inconclusive. Barker et al. (2004) found CSA changes of multifidus and psoas in patients with unilateral low back pain and associated these changes with pain and disability. Wan et al (2015) noted that the type of muscle changes in paraspinal muscles can vary between acute and chronic unilateral LBP, and that the severity of the muscle change may be influenced by symptom chronicity. Ryu et

al. (2012) studied the relationship between CSA of the lumbar muscles and chronicity of LBP and emphasized the relevance of the morphology of the erector spinae muscles. Dangaria and Naesh (1998), on the other hand, reported changes of the CSA of the psoas major in patients with unilateral sciatica due to disc herniation. The results indicate that there is variability in morphology responses that depend on the muscle functions, clinical presentation, and location.

Another possible characteristic of lumbar dysfunction is bilateral muscular asymmetry. In patients with unilateral lumbosacral radiculopathy, Hyun et al. (2007) found a lack of multifid muscle on one side, or atrophy. Battié et al. (2012) studied the multifidus (MF) level-specific and side-specific asymmetry in order to understand how individual anatomical factors affect the relationship between MF asymmetry and LBP. In more recent studies, Park et al. (2025) studied sex specific difference in the asymmetry of paraspinal muscle of the lumbar spine and their associations with pain characteristics. However, it is unclear how much bilateral morphological asymmetry correlates to functional disability, especially in those with CLBP who do not have significant unilateral symptoms.

MRI allows a non-invasive technique for quantitative assessment of the morphology of the lumbar muscles by detailed visualization of soft tissues. Measuring individual muscle CSA at specific vertebral levels by standardised axial imaging, and comparing bilateral muscle groups through such imaging, can be used to measure individual muscle CSA. Fortin and Battié (2012) showed that measurements of paraspinal muscle were reliable when obtained using image-analysis software. Cooley et al. (2021) also demonstrated the reliability of and concurrent validity of T1- and T2-weighted MRI for assessing muscle CSA and fat composition. These techniques can be used for objective morphological evaluation, but the interpretation of muscle measurements should take into account demographic and anthropometric factors. The age-dependent changes of lumbar muscle degeneration were reported by Takayama et al. (2016), indicating that it is important to consider physiological changes when assessing the morphology of muscles.

The ODI is a authorized patient-reported outcome measure that is commonly used to assess functional disability associated with CLBP, which measures pain-related activities, mobility, personal care and social functioning. It has been shown to be clinically relevant to measure disability from lumbar disorders by Fairbank and Pynsent (2000). Some studies have examined relationships between muscle imaging parameters with functional measures. Nguyen et al. (2023) found relationships between multifidus morphology, duration of pain, disability and leg pain in secondary-care patients. Peng et al. (2025) found correlations between paraspinal muscle quality and clinical parameters such as pain duration and quality of life. However, results are not uniform, suggesting that muscle size is not necessarily a consistent measure of functional disability which has a multidimensional nature.

The multifidus, erector spinae and psoas major CSA, bilateral asymmetry, and functional impairment in Indian clinical populations have, however, received very less attention. In light of this, the current prospective cross-sectional study aimed to examine the relationship between the functional impairment (using ODI) in patients with CLBP in Puducherry, India, and the MRI-derived CSA of these three muscle groups at the L3 and L5 vertebral levels. Additionally, bilateral muscular asymmetry and the correlation between muscle CSA and body mass index (BMI) were evaluated. to gain a thorough understanding of the morphology of the lumbar muscles and its clinical significance. lumbar muscle morphology and its clinical importance. The multifidus, erector spinae and psoas major CSA, bilateral asymmetry, and functional impairment in Indian clinical populations have, however, received very less attention. In light of this, the current prospective cross-sectional study aimed to investigate the relationship between the functional impairment (using ODI) in patients with CLBP in Puducherry, India, and the MRI-derived CSA of these three muscle groups at the L3 and L5 vertebral levels. Additionally, bilateral muscular asymmetry and the correlation between muscle CSA and body mass index (BMI) were evaluated.

2. MATERIALS AND METHODS

2.1. Study Design and Setting

The present work is a prospective, observational, cross-sectional study carried out in the Department of Orthopaedics, “Mahatma Gandhi Medical College and Research Institute (MGMCRI), Puducherry, India along with the Department of Radiology.” This study was conducted from April 2025 to May 2026 and aimed to examine the relationship between MRI derived lumbar muscle CSA and functional disability in CLBP patients. Participants were recruited from Orthopaedic Outpatient Department and casualty service. The clinical evaluation was carried out following a standardised study protocol, together with a functional assessment, and muscle measurement using MRI.

2.2. Study Population and Eligibility Criteria

In the study, 36 patients between the ages of 18 and 65 years with back pain of more than 12 weeks' duration were included. There were no exclusion criteria for patients and they were eligible regardless of sex. Patients with multilevel lumbar disc herniation, spinal trauma, spinal canal stenosis, spinal malignancy, spinal infection, history of lumbar surgery, or bleeding diathesis were excluded. The participants who were eligible were subjected to clinical examination, functional disability assessment and MRI of the lumbar spine for obtaining the necessary measurements for statistical study.

2.3. Sample Size Determination

The described sample size estimation using the single-proportion formula:

$$n = \frac{Z_{1-\alpha/2}^2 P(1 - P)}{d^2}$$

where $Z_{1-\alpha/2} = 1.96$, the anticipated proportion (P) was 0.50 , and the allowable estimation error (d) was 0.08 . These parameters yielded an estimated sample size of approximately 150 participants. However, the subsequently reported an

adjusted minimum of 33 participants without specifying the adjustment procedure. The final study population comprised 36 patients, and all participants were included in the analysis.

2.4. Demographic and Clinical Assessment

A standardized study proforma was used to gather baseline demographic and clinical data. The following data were collected: age, sex, height, weight, BMI, occupation, duration of low back pain, radiating symptoms and pertinent medical and surgical history. Work demands were used to classify the occupational characteristics. The attending orthopedic faculty performed clinical evaluation of all patients. BMI was estimated as body weight (kg) divided by the square of body height (m²). After a clinical evaluation, the participants filled in a functional disability questionnaire and received an MRI assessment.

2.5. Assessment of Functional Disability

Functional disability was considered using the ODI, Version 2.0, a ten-item patient-reported questionnaire evaluating the functional consequences of low back pain. The domains included Pain severity, self-care, lifting, walking, sitting, standing, sleeping, social life, travel, and work or homemaking activities. Each domain contained six response options scored from 0 to 5, with higher scores indicating greater functional limitation. The percentage disability score was calculated as:

$$\text{ODI (\%)} = \frac{\text{Total raw score}}{50} \times 100$$

For statistical analysis, the ODI raw score (0-50) was retained. Disability severity was categorized as having no disability (0–4), mild disability (5–14), moderate disability (15–24), severe disability (25–34), and complete disability (35–50), according to the categories specified in the study protocol. The questionnaire was administered in English or Tamil, with assistance from a trained research associate when required.

2.6. MRI Acquisition and Lumbar Muscle Measurements

All the participants had the Lumbosacral MRI with whole-spine screening at Department of Radiology, MGMCRI. The imaging protocol incorporated sagittal T1- and T2-weighted sequences and axial T2-weighted sequences from the L1–L2 to the L5–S1 intervertebral levels. Images obtained on the T2-weighted axial plane were chosen for quantitative muscle assessment because they allowed visualisation of the boundaries of the muscles and separation of the surrounding soft tissues.

CSA was measured at the conventional site on the inferior endplates of L3 and L5. Three bilateral muscle groups were assessed: the multifidus, the erector spinae, and the psoas major, located medially adjacent to the spinous processes, laterally adjacent to the multifidus and anterior to the transverse processes, respectively. Muscle boundaries were manually traced with the region of interest tracing tool available in the MRI analysis software. CSA was automatically calculated by the software in square centimetres (cm²). All measurements were made with one trained observer, working with the radiology department.

Twelve CSA measurements were taken for each participant: right and left multifidus, erector spinae and psoas major muscles at both L3 and L5. The four measurements for each muscle group were summed up to obtain its total CSA. The total muscle CSA was the sum of all three muscle groups.

2.8. Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics, Version 22 (IBM Corp., Armonk, NY, USA). Continuous variables, including age, BMI, ODI raw scores, muscle CSA, and asymmetry indices, were summarised using means and standard deviations, with ranges where applicable. Categorical variables were expressed as frequencies and percentages.

Pearson's correlation coefficient (r) was used to examine associations between muscle CSA and ODI raw scores, muscle CSA and BMI, and muscle asymmetry indices and ODI raw scores. Correlation significance was evaluated using the corresponding t-statistic with 34 degrees of freedom (n – 2). Descriptive comparisons were undertaken according to sex, age categories (younger than 40 years, 40–59 years, and 60 years or older), and BMI classifications. All statistical tests were two-tailed, and p-values below 0.05 were considered statistically significant.

Microsoft Excel was used to input the data which was then analysed using IBM SPSS Statistics Version 22 (IBM Corp., Armonk, NY, USA). The age, BMI, ODI raw scores, muscle CSA and asymmetry indices were summarized by means and standard deviations, and ranges as appropriate. For categorical variable, frequencies and percentages were used. The association between muscle CSA and ODI raw scores, muscle CSA and BMI, and muscle asymmetry indices and ODI raw scores were analyzed using Pearson's correlation coefficient (r). The analysis of correlation significance was done by the use of the corresponding t-statistic (number of freedom is 34, n – 2). Comparisons were made by sex, age (younger than 40, 40- to 59-year-olds, and 60-year-old or older), and BMI classification. All statistical tests were two-tailed, p<0.05 was regarded as significant.

2.9. Ethical Considerations

The study was conducted after approval by the "Institutional Human Ethics Committee of MGMCRI" and the ethical guideline for biomedical research on human participants as per the Declaration of Helsinki and the ethical guidelines of "Indian Council of Medical Research." All participants gave written learned consent prior to enrollment. The subjects were given information in English or Tamil on the purpose of the study, methods and confidentiality measures. Unique

study identification numbers were used to anonymise identifiable information and research data were kept securely and only accessible by authorised investigators.

3. RESULTS

36 individuals with persistent low back pain CLBP lasting longer than 12 weeks were included in this prospective observational study. Every participant had full demographic, clinical, and muscle CSA data generated from MRI with no missing data. Quantitative analysis was done on the bilateral psoas major muscles, multifidus, and erector spinae at the L3 and L5 spinal levels. The association between muscle morphology, functional impairment, and BMI was examined using Pearson's correlation coefficient, where $p < 0.05$ was deemed weighty.

3.1. Demographic and Clinical Characteristics of the Study Population

The age of the participants was 42.39 ± 13.05 years (range 20–64). Most participants were aged between 40- and 59 years (55.6%), with 38.9% under 40 years and 5.6% 60 years and over. The study population included 19 males (52.8%) and 17 females (47.2%). The majority of workers (41.7%) were homemakers, followed by heavy manual workers (27.8%), sedentary or light workers (19.4%) and workers in moderate or service occupations (11.1%).

The mean BMI was 31.27 ± 3.67 kg/m², with 55.6% classified as obese, 38.9% as overweight, and 5.6% within the normal BMI range. The mean ODI raw score was 22.42 ± 6.58 out of 50. Most were in the moderate disability category (58.3%), followed by severe disability (30.6%), mild disability (8.3%) and complete disability (2.8%). Demographic and clinical data are summarized in Table 1 and are shown graphically in Figure 1 for the age, sex, occupation, BMI and ODI scores.

Table 1. Demographic and clinical characteristics of patients with chronic low back pain (N = 36)

Variable	Category	Value / n (%)
Age (years)	Mean $\pm$ SD	42.39 $\pm$ 13.05
	Range	20–64
	< 40 years	14 (38.9%)
	40–59 years	20 (55.6%)
	$\geq$ 60 years	2 (5.6%)
Gender	Male	19 (52.8%)
	Female	17 (47.2%)
Occupation (physical demand)	Homemaker	15 (41.7%)
	Heavy manual labour	10 (27.8%)
	Sedentary / light	7 (19.4%)
	Moderate / service	4 (11.1%)
BMI (kg/m ²)	Mean $\pm$ SD	31.27 $\pm$ 3.67
	Normal (18.5–24.9)	2 (5.6%)
	Overweight (25–29.9)	14 (38.9%)
	Obese ($\geq$ 30)	20 (55.6%)
ODI severity	Mean $\pm$ SD	22.42 $\pm$ 6.58
	Mild (5–14)	3 (8.3%)
	Moderate (15–24)	21 (58.3%)
	Severe (25–34)	11 (30.6%)
	Complete (35–50)	1 (2.8%)
ODI raw score bins (/50)	5–9	1 (2.8%)
	10–14	2 (5.6%)
	15–19	10 (27.8%)
Variable	Category	Value / n (%)
	20–24	11 (30.6%)
	25–29	9 (25.0%)
	30–34	2 (5.6%)

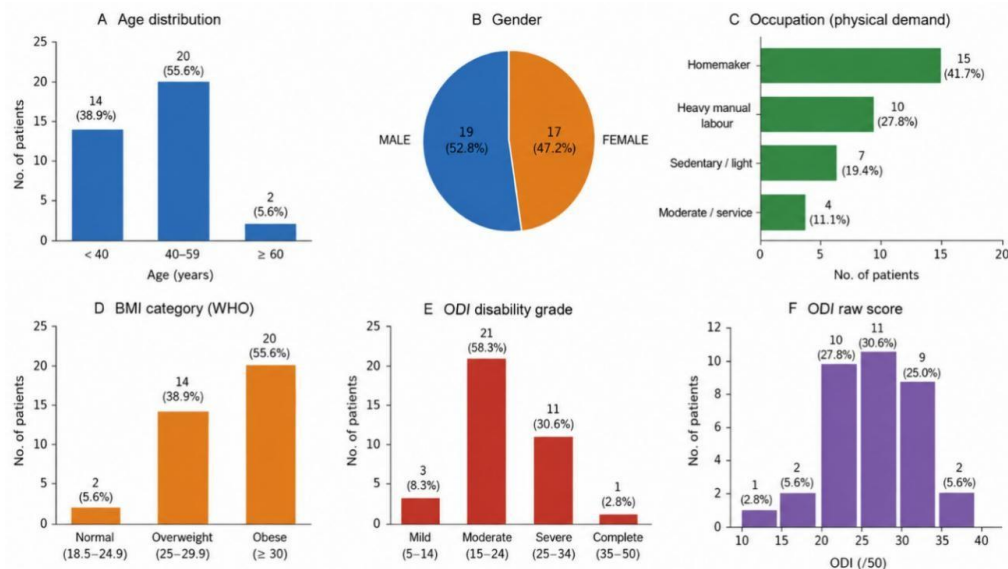


Figure 1. Demographic and clinical profile: (A-F) age, sex, occupation, BMI category, ODI grade and raw ODI score

3.2. MRI-Derived Lumbar Muscle Cross-Sectional Area

The muscle CSA differences across muscle groups and levels were confirmed by quantitative MRI assessment. The erector spinae exhibited the greatest combined bilateral CSA across L3 and L5 ($48.47 \pm 13.79 \text{ cm}^2$), followed by the psoas major ($39.19 \pm 12.46 \text{ cm}^2$) and multifidus ($21.13 \pm 6.43 \text{ cm}^2$). The total CSA of the three muscle groups was $108.79 \pm 27.35 \text{ cm}^2$, ranging from 65.02 to 172.26 cm^2 .

The CSA of the erector spinae was the greatest in both sides at the L3 level ($14.68 \pm 3.69 \text{ cm}^2$ (right) and $14.50 \pm 3.85 \text{ cm}^2$ (left)). The corresponding psoas major values were $8.12 \pm 3.16 \text{ cm}^2$ and $8.47 \pm 3.34 \text{ cm}^2$, while the multifidus measured $4.79 \pm 1.37 \text{ cm}^2$ and $4.87 \pm 1.24 \text{ cm}^2$, respectively.

At L5, the CSA of the psoas major (right $11.39 \pm 3.73 \text{ cm}^2$ and left $11.21 \pm 3.48 \text{ cm}^2$) was greater than that of the erector spinae. The erector spinae measured $9.78 \pm 4.07 \text{ cm}^2$ and $9.51 \pm 4.32 \text{ cm}^2$, whereas the multifidus measured $5.60 \pm 2.38 \text{ cm}^2$ and $5.87 \pm 2.50 \text{ cm}^2$, respectively. The difference in these anatomical parameters and the distribution of muscle CSA are given in Table 2 and in Figure 2A.

Table 2. MRI-derived muscle cross-sectional area at L3 and L5 (cm^2 ; N = 36)

Muscle	L3 Right	L3 Left	L5 Right	L5 Left	Total CSA
Multifidus	4.79 ± 1.37	4.87 ± 1.24	5.60 ± 2.38	5.87 ± 2.50	21.13 ± 6.43
Erector spinae	14.68 ± 3.69	14.50 ± 3.85	9.78 ± 4.07	9.51 ± 4.32	48.47 ± 13.79
Psoas major	8.12 ± 3.16	8.47 ± 3.34	11.39 ± 3.73	11.21 ± 3.48	39.19 ± 12.46

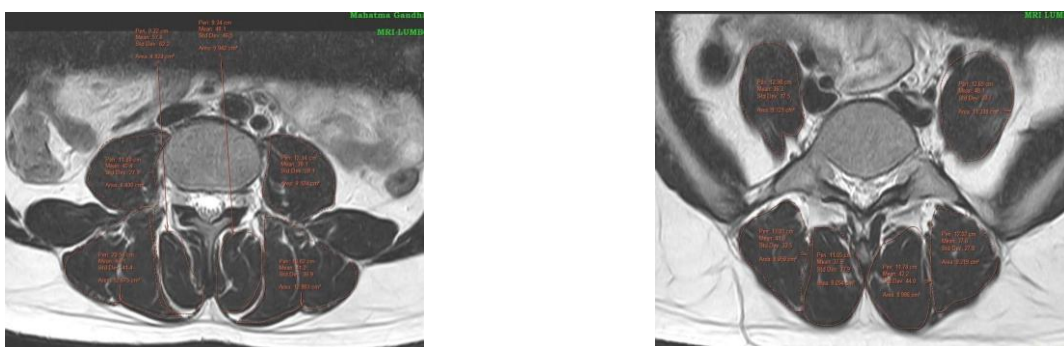


Figure 2. Representative axial MRI measurements of lumbar muscles at (A) L3 and (B) L5

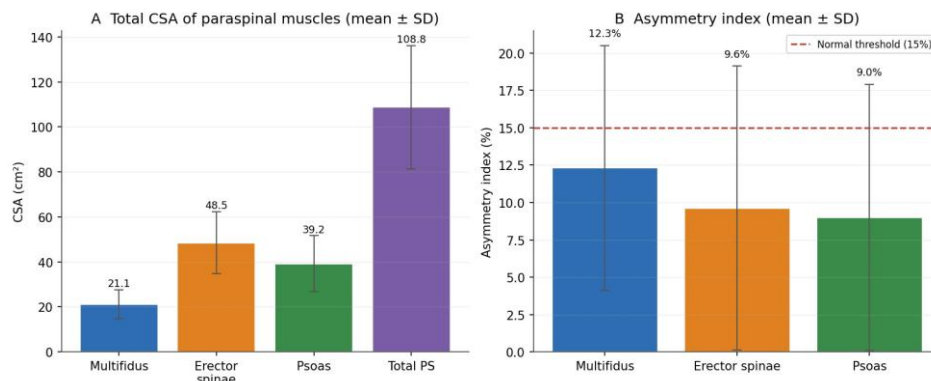
3.3. Bilateral Asymmetry of Lumbar Paraspinal Muscles

There were contrasts between the three assessed muscle groups in terms of bilateral muscle asymmetry. The mean asymmetry index (AI) was highest in the multifidus ($12.31 \pm 8.18\%$), followed by the erector spinae ($9.62 \pm 9.51\%$) and psoas major ($9.00 \pm 8.91\%$). The observed AI ranges were 0.27–31.89% for the multifidus, 0.54–41.16% for the erector spinae, and 0.10–48.57% for the psoas major.

13 participants (36.1%) had multifidus asymmetry greater than 15%, whereas 8 participants (22.2%) had asymmetry greater than 15% in erector spinae and 6 (16.7%) in psoas major. Therefore, it was the multifidus that had the most average bilateral asymmetry and highest percentage of individuals with asymmetry above the threshold. The asymmetry indices are summarised in Table 3 and shown in Figure 2B.

Table 3. Asymmetry index (%) of lumbar muscle groups (N = 36)

Muscle	Asymmetry index (mean $\pm$ SD, %)	Range (%)	n (%) with AI > 15%
Multifidus	12.31 $\pm$ 8.18	0.27–31.89	13 (36.1%)
Erector spinae	9.62 $\pm$ 9.51	0.54–41.16	8 (22.2%)
Psoas major	9.00 $\pm$ 8.91	0.10–48.57	6 (16.7%)

**Figure 3. Total muscle cross-sectional area (A) and side-to-side asymmetry (B)**

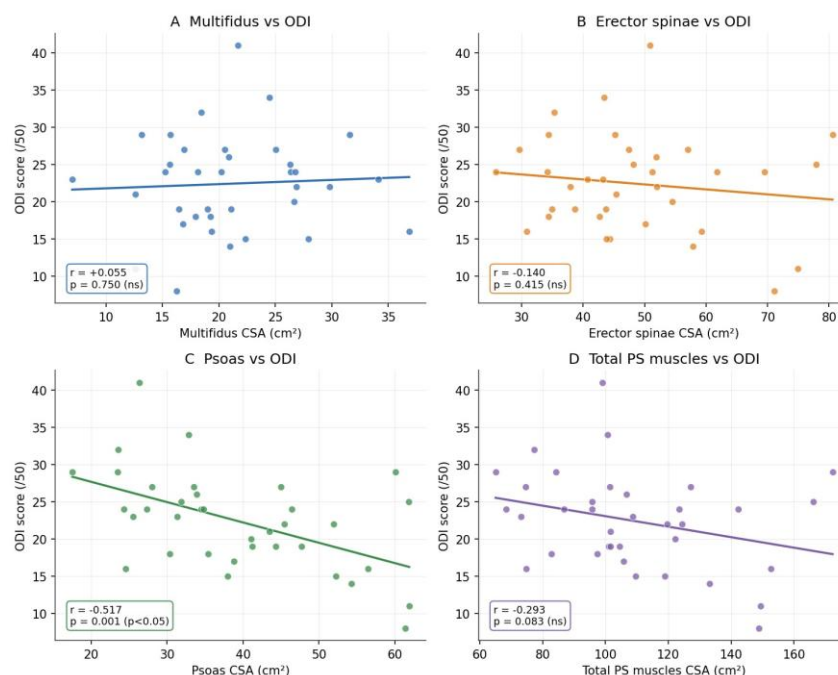
3.4. Association Between Muscle Cross-Sectional Area and Functional Disability

A statistically significant moderate negative connection between psoas major CSA and ODI raw scores was confirmed by Pearson correlation analysis ($r = -0.520$, $t = -3.520$, $p = 0.001$), indicating that individuals with smaller psoas major CSA likely to have greater functional impairment. The multifidus CSA and ODI scores did not significantly correlate ($r = 0.060$, $p = 0.750$), nor did the erector spinae CSA and ODI values ($r = -0.140$, $p = 0.415$).

However, the total CSA (from all three muscle groups combined) flashed a weak negative association with functional disability ($r = -0.290$, $p = 0.083$), but this was not significant. The psoas major was the only muscle with an unadjusted statistically significant association with functional disability. The detailed correlation coefficients and the statistical values are shown in Table 4 and the relationships are shown in Figure 3.

Table 4. Pearson correlation between muscle CSA and ODI raw score (n = 36, df = 34)

Correlation	Pearson r	t (df = 34)	p-value	Significance
Multifidus – ODI	0.060	0.320	0.750	Not significant
Erector spinae – ODI	-0.140	-0.820	0.415	Not significant
Psoas major – ODI	-0.520	-3.520	0.001	Significant
Total PS muscles – ODI	-0.290	-1.790	0.083	Not significant

**Figure 4. Scatter plots of total muscle CSA versus ODI raw score with fitted lines (A-D)**

3.5. Relationship Between Lumbar Muscle Cross-Sectional Area and Body Mass Index

The correlation between lumbar morphology and BMI taught that there was a statistically significant negative correlation between psoas major ($r = -0.440$, $t = -2.860$, $p = 0.007$). This result suggested that the study population had a negative correlation between BMI and psoas major CSA.

The total muscle CSA did not correlate with BMI ($r = -0.331$, $p = 0.051$), but combined total muscle CSA was negatively correlated with BMI ($r = -0.320$, $p = 0.057$). Erector spinae CSA ($r = -0.220$, $p = 0.190$) and multifidus CSA ($r = -0.030$, $p = 0.875$) also had negative, but nonsignificant, correlations with BMI. The results suggest a relationship between muscle CSA and BMI varies by individual muscle group, with only the CSA of the psoas major being statistically significant. The results are shown in Table 5 and in Figure 4.

Table 5. Pearson correlations between lumbar muscle cross-sectional area and body mass index (N = 36)

Correlation	Pearson r	t (df = 34)	p-value	Significance
Multifidus – BMI	-0.030	-0.160	0.875	Not significant
Erector spinae – BMI	-0.220	-1.340	0.190	Not significant
Psoas major – BMI	-0.440	-2.860	0.007	Significant
Total PS muscles – BMI	-0.320	-1.970	0.057	Not significant

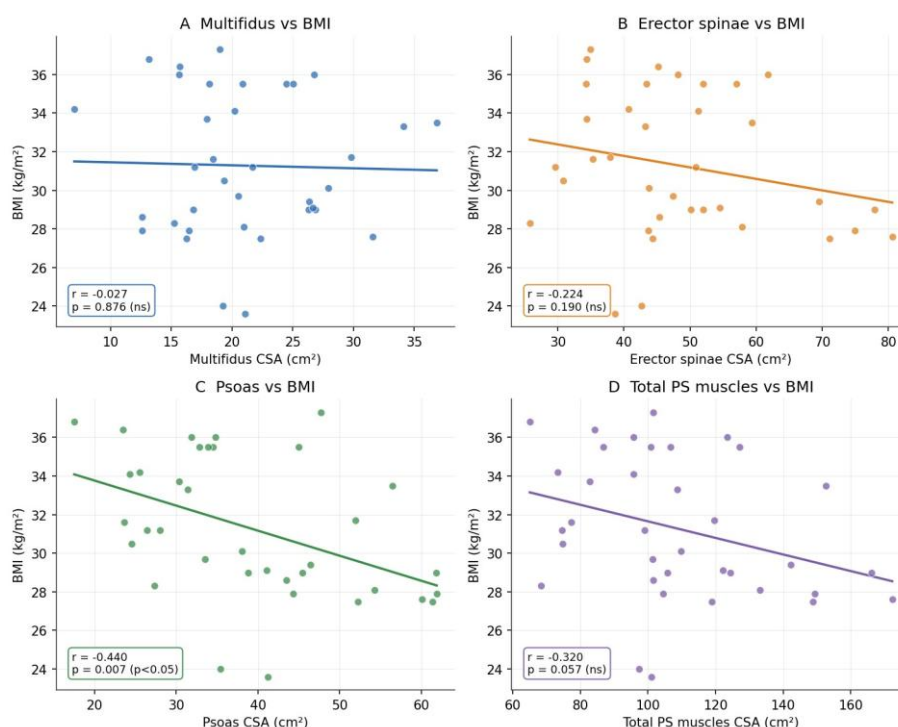


Figure 5. Scatter plots of total muscle CSA versus BMI with fitted lines (A-D)

3.6. Association Between Muscle Asymmetry and Functional Disability

The associations between muscular asymmetry and functional impairment were evaluated using Pearson correlation analysis. For every inquiry, there was no statistically significant correlation between the asymmetry index and the ODI's raw score. The erector spinae had a similarly modest negative association ($r = -0.020$, $p = 0.894$) while the multifidus had a very minor positive connection ($r = 0.010$, $p = 0.951$). The psoas major asymmetry index and ODI showed very little linear correlation ($r = 0.000$, $p = 0.999$).

All reported relationships were minor in magnitude ($|r| < 0.03$), even though 36.1%, 22.2%, and 16.7% of participants had an asymmetry index $>15\%$ for the multifidus, erector spinae, and psoas major, respectively. The findings demonstrated that the degree of functional dysfunction in the group under investigation did not significantly correlate with muscle asymmetry. Table 6 summarizes the correlation results, while Figure 5 displays associated graphs as a scatter plot.

Table 6. Pearson correlations between muscle asymmetry and ODI raw score (n = 36, df = 34)

Correlation		Pearson r	p-value	n (%) AI > 15%	Significance
Multifidus AI – ODI		0.010	0.951	13 (36.1%)	Not significant
Erector spinae AI – ODI	–	-0.020	0.894	8 (22.2%)	Not significant
Psoas major AI – ODI		0.000	0.999	6 (16.7%)	Not significant

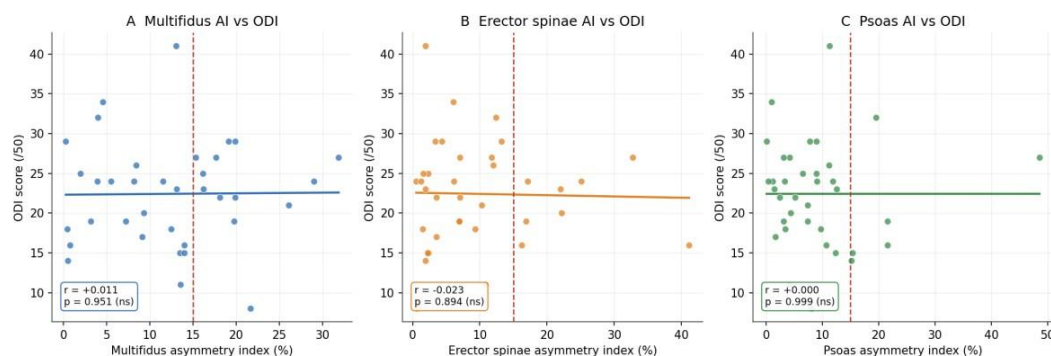


Figure 6. Scatter plots of muscle asymmetry index versus ODI raw score (A-C)

The relationships between bilateral muscle asymmetry indices and functional disability, measured using the ODI, are illustrated in Figure 6, demonstrating negligible correlations across the psoas major muscles, multifidus, and erector spinae.

3.7. Summary of Principal Findings

The present study demonstrated that MRI-derived psoas major CSA was negatively associated with functional disability and BMI among patients with CLBP, whereas multifidus CSA, erector spinae CSA, and combined total muscle CSA exhibited no statistically significant correlations with either outcome. Although the multifidus demonstrated the highest average asymmetry index and the greatest proportion of participants exceeding the 15% reference threshold, bilateral muscle asymmetry was not significantly associated with ODI scores. Overall, the findings identified psoas major CSA as the strongest observed muscular correlate of functional disability in this cohort, without establishing an independent or causal relationship.

4. DISCUSSION

This present study examined the correlation linking the MRI derived Lumbar Muscle CSA, muscular asymmetry at the L5/S1 level and functional disability of 36 patients with CLBP. The principal finding was that there was a momentous inverse correlation between psoas major CSA and ODI scores ($r = -0.520$, $p = 0.001$), but there were no significant associations between multifidus CSA, erector spinae CSA and the ODI scores. In addition, although measurable morphological differences were found there was no correlation between the severity of the disability and bilateral muscle asymmetry. The present results indicate that the clinical significance of lumbar muscle morphology could differ based on the muscle group analyzed.

The strong negative correlation between psoas major CSA and ODI suggests that smaller CSA of the psoas muscle is correlated with more functional limitations. This finding is similar to that of Barker et al (2004) who reported that CSA changes in multifidus and psoas were associated with disability in the patients with unilateral LP. Likewise, Dangaria and Naesh (1998) reported that patients with lumbar disc herniation-induced sciatica have decreased CSA of their psoas muscle on the affected side, especially if symptoms last longer than one month. The same effect was observed by Ploumis et al. (2011) with patients suffering from unilateral back pain and degenerative disc disease. Since the psoas major is associated with functional disability, it may provide a plausible biomechanical explanation for this association, as it is important for hip flexion and lumbar alignment as well as for spinal stability. Wan et al., (2015) however, showed some differences between AMLBP and CLBP in terms of morphological changes in the psoas, which suggests that muscular responses might vary according to clinical presentation and symptom characteristics. It is important to realize, therefore, that the observed association should be viewed as correlational, not necessarily causal in regard to the role of the reduction of the size of the psoas muscle in causing disability.

There were no significant associations between either multifidus CSA ($r = 0.060$, $p = 0.750$) or erector spinae CSA ($r = -0.140$, $p = 0.415$) and ODI scores. These results contradict previous studies that focused on the correlation between lumbar muscle morphology and clinical symptoms. Hides et al. (1994) reported multifidus muscle wasting in patients with acute and subacute low back pain. Later Parkkola et al. (1993) have shown that there is a difference in the lumbar muscle morphology in those with symptoms and those who are normal. More recently, Nguyen et al. (2023) found associations between multifidus morphology, pain duration and functional disability. The present investigation assessed total CSA, however, and muscle-quality changes associated with disability may be less apparent, due to the fact that it was total CSA and not functional CSA or intramuscular fat content. Moreover, Ryu et al. (2012) emphasized the importance of erector spinae morphology for the chronicity of low back pain, as muscle size seemed to be related to the duration of symptoms in different ways than concurrent disability. The lack of significant associations may also be due to the relatively small sample size and interindividual anatomical variability.

The mean asymmetry index ($12.31 \pm 8.18\%$) was the highest for the multifidus, with 36.1% of subjects above the 15% threshold used as a reference in this study. However, no significant correlations were found between asymmetry indices of the multifidus, erector spinae or psoas major and ODI scores. The asymmetry of the multifidus muscles was found to be not specific to pain, as reported by Battié et al. (2012). In the same way, Park et al. (2025) found that paraspinal muscle asymmetry was also different between sexes in CLBP patients. These observations indicate that bilateral asymmetry is not a sufficient measure of functional impairment, especially if it does not take into consideration the anatomy and distribution of clinical symptoms.

BMI was negatively correlated with CSA of the psoas major ($r = -0.440$, $p = 0.007$); therefore, anthropometric measurements may have an impact on the morphology of the lumbar muscles. The high percentage of overweight/obese

participants also underscores the need to take body composition into account when interpreting CSA measures. Takayama et al. (2016) have documented age-related paraspinal muscle degeneration such as a reduction in paraspinal muscle size and an increase in fatty infiltration. Peng et al. (2025) also noted links between the muscle quality and pain characteristics and the QOL in CLBP patients. The differences reported for sex and age in disability and muscle size, but which are yet to be confirmed with the individual-level data.

The results indicate that quantitative psoas major CSA assessment can be used to supplement morphological data in assessing patients with CLBP. Fortin and Battié (2012) showed that reproducible paraspinal muscle measurements can be performed with imaging software, which paves the way for further studies of the standardisation of MRI measurement. However the present study was unable to set diagnostic levels, predict outcome of clinical treatment, or assess the effectiveness of rehabilitation provided on a targeted basis.

However, there are a number of confounders to consider: the number of patients was small, there was no healthy control, a cross-sectional study design, and the CSA was not directly quantified, only total CSA. Measurement was carried out by one person and interobserver reliability testing reported. While MRI-based muscle assessment has shown to be a reliable method, methodological reliability is also critical for individual studies (Cooley et al. 2021). Also, conclusions for independent associations are limited because of the lack of multivariable adjustment. Larger prospective investigations that account for muscle composition, clinical factors and longitudinal functional outcomes are thus warranted.

In general, the results suggest psoas major CSA is a more reliable predictor of functional disability than CSF or bim SAs in this population, signaling a need for continued study of MRI muscle measurements in CLBP research. In general, the results suggest psoas major CSA is a more reliable predictor of functional disability than CSF or bim SAs in this population, signaling a need for continued study of MRI muscle measurements in CLBP research.

5. CONCLUSION

In this prospective cross-sectional investigation, 36 patients with chronic low back pain showed a strong inverse connection between functional impairment and psoas major cross-sectional area as determined by MRI. While smaller psoas CSA was associated with a higher ODI score, multifidus and erector spinae CSA did not significantly connect with the Oswestry Disability Index score. Measurable muscle differences between muscle groups were also not associated with ODI, as were bilateral muscle asymmetries. There was high level of functional limitation within the group, with most participants having moderate or severe disability. Additionally, the correlation of psoas CSA with BMI underscores the importance of anthropometric measures in assessing lumbar muscle morphology. These observations warrant deeper study of psoas CSA as an additional imaging modality but not a standalone causal effect or guidelines for routine clinical use. Results are limited in generalizability due to the small sample size, lack of healthy controls and the cross-sectional design. More multicenter, longitudinal, studies that include functional CSA, Fat infiltration and adjusted analyses and rehabilitation outcomes are needed to establish whether changes in muscle morphology correlate with clinically relevant outcomes.

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