

# **Relationship Between Paraspinal Muscle Size, Intramuscular Fat and Strength: Comparative Insights from Fat-Water MRI and Computer-Vision Analysis in Chronic Low Back Pain and Controls**

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## **Introduction**

Chronic low back pain (CLBP) is the most prevalent cause of, and contributor to, disability worldwide with associated paraspinal muscle weakness. However, the relationships between paraspinal muscle size (e.g., cross-sectional area [CSA], volume), quality (e.g., intramuscular fat [IMF]) and strength remain largely unknown, warranting further investigation. This exploratory study examined the relationship between paraspinal muscle size (e.g., CSA and volume), quality (e.g., IMF), and lumbar extensor muscle strength at upper (e.g., L1-L3) and lower (e.g., L4-S1) lumbar spinal level in people with and without CLBP.

## **Materials and Methods**

Forty-four participants were recruited: 22 with CLBP (15 females, 7 males; mean age of  $44.68 \pm 12.31$  years old) and 22 without CLBP (11 females, 11 males; mean age of  $38 \pm 10.56$  years old). Isometric lumbar extension strength was measured at seven angles using the MedX lumbar extension machine. IDEAL fat-water Magnetic Resonance Imaging (MRI) sequences were used to quantify CSA, volume, and IMF of the MF, ES, psoas (PS) and quadratus lumborum (QL) bilaterally from L1-S1. Automatic segmentation of the paraspinal muscles was performed using a computer vision model, also allowing for the quantification for the spatial distribution of IMF. Multiple linear regression analyses were conducted to evaluate the associations between paraspinal muscle size and quality with mean isometric strength at the upper (e.g., L1-L3) and lower (e.g., L4-S1) lumbar levels, adjusting for age, sex, and body mass index (BMI).

## **Results**

In the CLBP group, greater volume of the MF, ES, and PS was significantly associated with higher mean extension strength at the lower lumbar levels. In both groups, greater ES CSA was positively associated with mean strength at the upper lumbar levels. IMF was not significantly associated with strength in either group, with the exception of deeper IMF in the PS at the lower lumbar levels which was negatively associated with mean strength in the LBP group. BMI was most strongly associated with muscle morphology across both groups, while age and sex showed variable associations.

## **Conclusion**

Paraspinal muscle size, particularly greater CSA and volume of the MF, ES, and PS, was positively associated with lumbar extension strength in both groups. Notably, localized IMF in the PS at the lower lumbar levels was negatively associated with strength in individuals with LBP. These findings highlight that targeted rehabilitation strategies aimed at improving muscle size and reducing deep IMF may enhance strength and support better clinical outcomes in the management of patients with CLBP.