

# Impact of MRI-derived paraspinal muscle quality on surgical outcomes and the need for reliable automation

## Abstract

### Purpose

Paraspinal muscle (PSM) quality is associated with surgical outcomes and broader spinal health, yet its quantification remains inconsistent and labor intensive. This narrative review summarizes the clinical evidence linking PSM quality to outcomes, compares current MRI-based measurement techniques, and outlines requirements for automated tools supporting large-scale research and clinical integration.

### Methods

PubMed/MEDLINE and Google Scholar were searched without date restrictions for English-language studies. The domains reviewed included clinical outcome evidence, MRI-based measurement techniques, and the methodological limitations constraining both. Requirements for an automated pipeline and a staged roadmap toward clinical translation are proposed.

### Results

The multifidus, erector spinae, and psoas major have been repeatedly associated with postoperative disability, pain, reoperation, and complications. Cross-sectional area and fatty infiltration are the most widely validated biomarkers. Automated measurement methods have drastically reduced processing times with consistently high segmentation performance, enabling the expansion of previously small cohorts constrained by manual segmentation methods to several thousand participants. However, automated pipelines are not yet end-to-end and still require manual input. Further, automated fat quantification is less reliable, with reduced agreement in pathological cohorts and greater sensitivity to image artifacts. Heterogeneity in imaging, segmentation protocols, and fat quantification persists across automated tools with no common reference standard for validation, limiting cross-study comparison.

### Conclusion

The central barrier to clinical integration of PSM biomarkers is achieving standardized, reliable measurement. A staged path from consensus fat quantification methodology, through generalizable end-to-end pipelines and outcome-validated cutoffs, to a comprehensive and integrated spine assessment would allow informed surgical decision-making and patient care.

### Keywords

Paraspinal muscle, Muscle quality, Fatty infiltration, Deep learning, Muscle segmentation, Spine surgery