

## Assessment of spinal and pelvic kinematics using inertial measurement units in people with persistent low back pain

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**Introduction:** Clinical guidelines for management of persistent low back pain (LBP) endorse individually tailored exercise. Exercises are frequently tailored based on visual assessment of posture and movement leading to gross estimates of range and quality of movement. Inertial measurement units (IMUs) are a portable quantitative method of motion capture, but their use in LBP is limited.

**Purpose/Aim:** To assess the utility of IMUs for detecting differences in spinal and pelvic kinematics in individuals with and without LBP, and discerning between two commonly clinically encountered directional LBP patterns.

**Materials and Methods:** Eighty-two participants with LBP with flexion (F-LBP; n=38) and extension (E-LBP; n=43) directional pain pattern and 26 pain-free controls (No-LBP) attended a single laboratory session. IMUs were placed on the spinous processes of the 4<sup>th</sup> and 2<sup>nd</sup> lumbar vertebra to record lower (LLx) and upper (ULx) lumbar spine movement, respectively, 7<sup>th</sup> cervical vertebra to record total spine/trunk (TT) movement and sacrum to record pelvis movement. Participants performed 10 repetitions of forward flexion, extension, lateral flexion, squat and sit-to-stand. For each region (ULx, LLx, TT, pelvis), ROM was quantified from IMU orientation in the primary plane of movement. ROM was averaged across repetitions and compared across LBP and No-LBP with an unpaired t-test and across F-LBP, E-LBP and no-LBP with one-way analysis of variance.

**Results:** Compared to No-LBP, individuals with LBP had less flexion at ULx ( $p=.005$ ), LLx ( $p=.003$ ) and TT ( $p=.01$ ; Figure 1), and less extension although the between-group ROM difference was smaller and significant only at LLx. LBP individuals had significantly less lateral tilt at the pelvis compared no-LBP with no between-group differences in the spine during lateral flexion. Subgroup analysis revealed E-LBP had smaller ROM than No-LBP at LLx during flexion (Bonferroni-corrected post-hoc  $p=.005$ ), extension ( $p=.013$ ), and lateral flexion ( $p=.038$ ) and at pelvis during lateral flexion ( $p=.005$ ; Figure 1). F-LBP had smaller ROM than No-LBP at ULx during flexion ( $p=.024$ ; Figure 1) but no other differences across the remaining tasks or regions. There were no differences between groups at any spine region during sit-to-stand and squat.

**Conclusion(s):** IMUs detected differences in the whole trunk and regional spinal and pelvic kinematics between people with and without LBP during flexion, extension and lateral flexion tasks, with a consistent trend of reduced ROM in LBP but no differences in more functional tasks. The changes in ROM differed according to the directional LBP pattern indicating the potential utility of IMUs for assessment of spinal kinematics to tailor exercise and monitor efficacy in LBP. A single IMU may be sufficient to quantify gross movement characteristics such as ROM deficits associated with LBP, but doesn't offer sufficient granularity to characterise variations across subsets of LBP potentially requiring different rehabilitation protocols.

**Keywords:** persistent low back pain, inertial measurement units, assessment

Figure 1. Group differences between LBP and no-LBP as well as subgroups during flexion, extension, lateral flexion, sit to stand and squat.

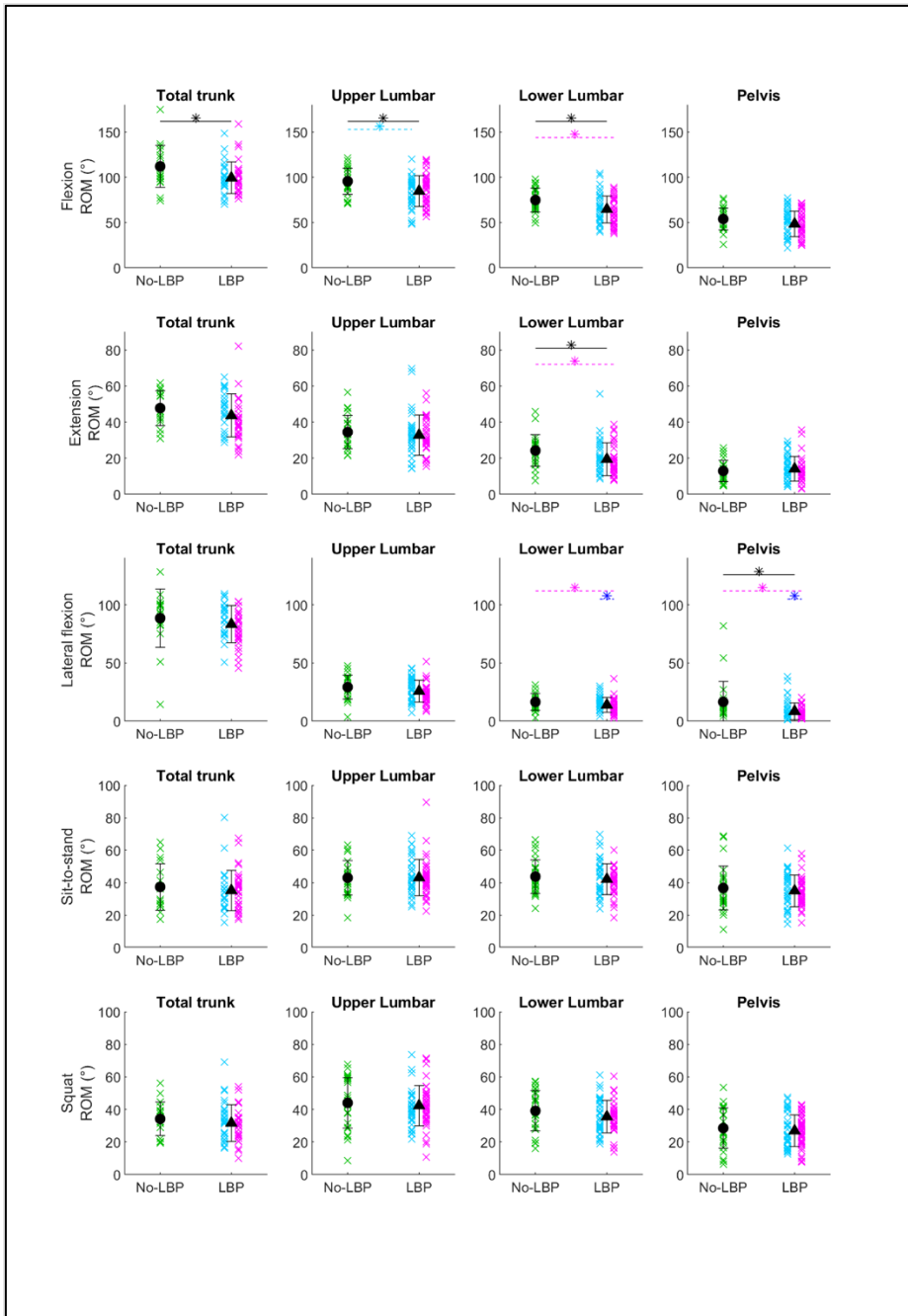


Figure 1 Key: Range of motion during flexion, extension, and lateral flexion in individuals with low back pain (LBP) flexion (F-LBP) (blue) and extension (E-LBP) (pink) directional pain pattern and without low back pain (No-LBP; green). Black triangles and circles indicate the group mean for LBP and No-LBP groups, respectively, and error bars indicate standard deviation. Black asterisks indicate significant difference between LBP and No-LBP ( $t$ -test  $p < .05$ ). Blue asterisk indicates significant difference between F-LBP and No-LBP; pink asterisks indicate significant difference between LBP-E and No-LBP (Bonferroni-corrected post-hoc pairwise comparison  $p < .05$  after significant main effect of group in one-way analysis of variance).