Sex differences and the influence of chronic low back pain on gait patterns: a kinematic and kinetic analysis

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Summary

This study analyzed pelvic and lower extremity gait patterns in pain-free individuals and patients with chronic low back pain (cLBP). Significant sex-based differences were observed in pelvic obliquity, hip, knee, and ankle mechanics. CLBP was associated with changes in ankle flexion / extension angle pattern in females. Further research is needed to investigate the impact of sex differences on the relationship between gait patterns and pain and to explore how small alterations in ankle kinematics affect gait performance and contribute to cLBP.

Introduction

Gait studies in chronic low back pain show inconsistent results due to varying classifications of cLBP and a lack of sex-specific analysis. This study addresses these gaps by examining pelvic and lower extremity gait patterns in pain-free females and males, and in a specific cLBP subgroup, stratified by sex.

Methods

Participants with a history of diagnoses, injuries, or surgeries affecting the spine or lower extremities were excluded as well as those with lumbo-pelvic MRI findings exceeding a defined threshold in disc or facet degeneration, herniation, osteochondrosis, spondylolisthesis, or spinal canal stenosis. CLBP patients reported lumbar pain nearly daily for ≥12 weeks, while pain-free individuals ranked above the 25th percentile in all eight categories of the SF-36 compared to the German normative cohort. Gait data were recorded in a marker-based 3D motion capture environment equipped with a two-belt treadmill with two force plates at self-selected speed and 4 km/h. 41 cLBP patients (28f, 13m) and 53 pain-free individuals (34f, 19m) were included. Functional regression models were used for analysis. Two hypotheses were tested: Significant differences are present in (a) Pelvic, hip and ankle mechanics between pain-free females and males and (b) pelvic, hip, and knee joint mechanics between cLBP patients and pain-free individuals.

Results and Discussion

The analysis revealed significant sex-based differences in pelvic obliquity over the left and right gait cycles at both self-selected speed and 4 km/h, particularly from mid-stance to terminal stance and during initial and mid-swing ($p < 0.001$ to 0.005) (Figure 1). Significant differences were also found in hip ab- / adduction and rotation, knee flexion / extension moments, and ankle angles and moments. These differences can be attributed to many factors, including socio-cultural characteristics, such as sexual attractiveness and anatomical differences, such as a wider pelvis and greater femoral anteversion in females [2,3].

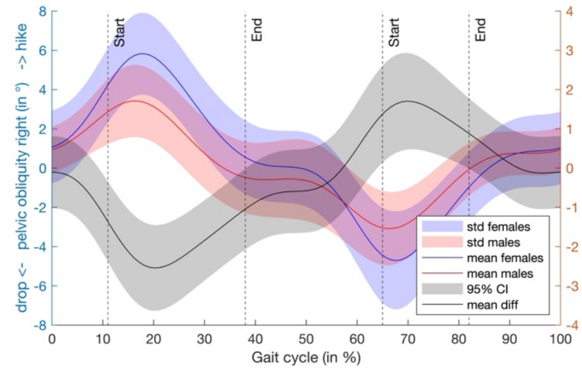

Figure 1: Pelvic obliquity in females and males without back pain.

Unexpectedly, functional regression revealed a significant difference in ankle flexion / extension angle between pain-free females and females with cLBP while walking at a self-selected speed and at 4 km/h ($p = 0.03$ and $p = 0.04$). This difference was observed in the left ankle gait pattern between approximately 58% and 77% of the gait cycle. It indicates reduced plantar flexion at toe-off in the cLBP group which may reflect altered muscle function or increased stiffness in the plantar flexors [4]. Since no other significant kinematic or kinetic differences were found it remains unclear whether these changes have functional significance.

Conclusions

The findings highlight the importance to consider sex in cLBP gait studies. Further analysis needs to examine how small alterations in ankle kinematics influence gait efficiency and how it contributes to cLBP.

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