

# Effect of walking speed on spine movement in adolescent idiopathic scoliosis: A statistical parametric mapping analysis

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## Summary

This study aimed to understand the effect of walking speed on multi-segment spine movement in children with scoliosis, using statistical parametric mapping analysis. Significant differences in segment angles were observed across spine segments and movement planes during the stance phase of gait. Further research is needed to explore the relationship between walking speed, spinal curvature magnitude, and laterality.

## Introduction

Previous research indicates that individuals with pathology walk more slowly than those without. Studies also suggest that walking speed affects the amplitude of lower limb joint kinematics in children without pathology [1]. As part of a broader program of work examining subtle movements in children with adolescent idiopathic scoliosis (AIS), this study explores the effect of walking speed on multi-segment spine movement.

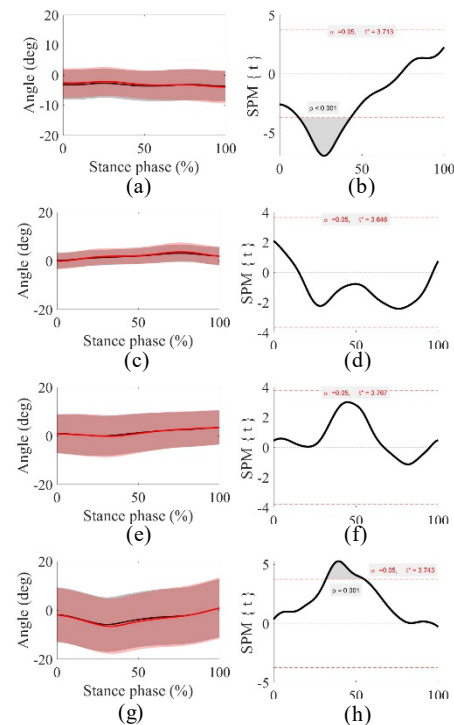
## Methods

Following ethical approval, ten female participants ( $14 \pm 1.5$  years,  $1.66 \pm 3.6$  m,  $53.5 \pm 9.6$  kg) with AIS were recruited. A 10-camera motion capture system (Vicon, Oxford, UK) collected marker trajectory data at 100 Hz. Reflective markers were attached to the spine, back, pelvis and lower limbs [2,3], with the spine divided into four segments (upper thoracic, lower thoracic, upper lumbar and lower lumbar). Participants were required to walk barefoot at their preferred walking speed ( $1.09 \text{ m/s} \pm 0.13$ ) and fast walking speed ( $1.44 \pm 0.15$  m/s). Data from 5 trials were time-scaled, normalised to 100% of the stance phase, and analysed using Statistical Parametric Mapping (SPM) [4].

## Results and Discussion

SPM hypothesis test results showed that different walking speeds resulted in significant differences in segment angles across the four spine segments and the three planes of motion. For example (see Figure 1), increases in the segment angle of the upper thoracic at 12-43% (Figure 1b) and the lower lumbar at 32-55% (Figure 1h) of the stance phase were evident when fast-walking speed was compared to preferred. Consistent with previous research on individuals with scoliosis, greater range of motion was seen in the upper and lower lumbar segments than in the upper and lower thoracic segments. Although the range of motion increases across all segments, it's important to consider that these individuals often adopt a

protective or guarded movement strategy. However, as shown in a previous study [5], this strategy depends on the curve characteristics, including its magnitude and laterality.



**Figure 1:** Frontal plane segment angles for upper (a) and lower (c) thoracic and upper (e) and lower (g) lumbar for preferred (black) and fast (red) walking speed, and SPM results (b, d, f, h).

## Conclusions

Walking speed influenced spinal kinematics in individuals with AIS. Further research with homogeneous groups, matched for curve characteristics, is needed to explore the relationship between walking speed, spinal curvature magnitude, and laterality.

## Acknowledgments

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## References

- [1] Fukuchi CA et al. *Syst Rev* **8**: 153, 2019.
- [2] Christie G et al. *J Biomech* **49**: 2060-2067, 2016.
- [3] Leardini A et al. *Gait Posture* **26**: 560-71, 2007
- [4] Pataky T.C., et al. *J Biomech*, **46**: 2394-2401, 2013.
- [5] Ji R et al. *Biomed Eng Online*. **23**:22, 2024.