



# Kids Run Differently: A Preliminary Analysis of Adolescent Two-dimensional Running Kinematics

Yukiko Matsuzaki, PT, DPT, OCS, SCS<sup>1</sup>, Madison R. Heath, BS<sup>2</sup>, Alexandra Tananbaum, PB-BS, BA<sup>2</sup>, Peter D. Fabricant, MD, MPH<sup>2</sup>  
HSS | Hospital for Special Surgery, New York, NY



## INTRODUCTION

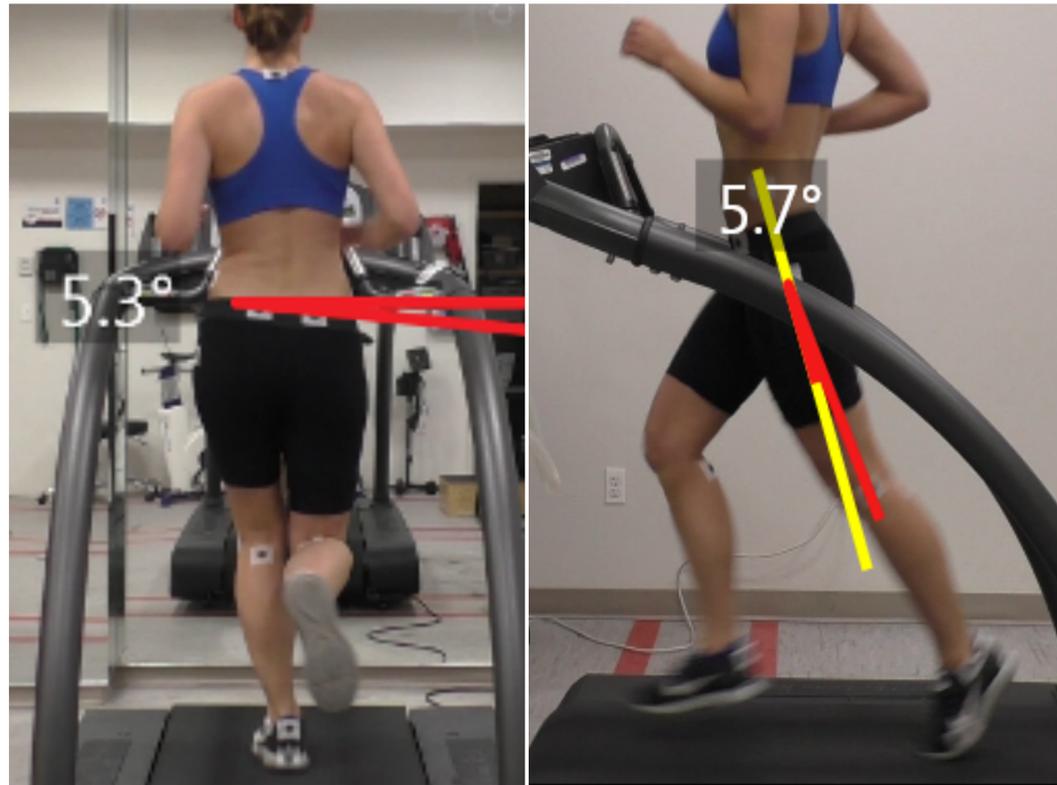
- Running-related overuse injuries are common, and there is evidence that links altered kinematics to running-related injury.
- While previous studies have identified normal running biomechanics in adults, there is little research on youth distance runners. The current normative biomechanical values and guidelines for adults may not apply to adolescent runners.
- This study aims to describe two-dimensional running kinematics in healthy adolescent distance runners.

## PARTICIPANTS

- Healthy, uninjured runners between 14 and 18 years of age who ran a minimum of 5 miles per week.
- Exclusion criteria: history of lower extremity deformity or surgery, chronic musculoskeletal or neuromuscular disease, pain anywhere in the body at the time of the study, or an acute injury three months prior to participation in the study that led to inability to run  $\geq 3$  consecutive days

## METHODS

- Markers were applied to anatomic landmarks throughout the trunk, pelvis, and lower extremities.
- After a 6 min warm-up, athletes ran at a self-selected speed on a treadmill.
- 30 second video clips were obtained using one high-definition camera from 5 views.
- Frontal and sagittal plane running kinematics were assessed using Dartfish Motion Analysis Software<sup>TM</sup>.



## RESULTS

- 36 runners participated (50% males), mean age of 16 years old.
- Mean training volume at the time of participation was 19 miles per week.
- 44% were “highly specialized” according to the Jayanthi Sports Specialization score and the mean HSS Pedi-FABS score was 20.8.

|                                    | Mean (SD)     | Recommended adult values | N (%) in recommended adult range (out of 72 limbs) | N (%) in recommended adult range bilaterally (out of 36 participants) |
|------------------------------------|---------------|--------------------------|--|---|
| Knee flexion angle at IC (degrees) | 13.13 (3.96)  | 20-25 <sup>1-3</sup>     | 0 (0%)   | 0 (0%)  |
| Knee flexion angle at MS (degrees) | 44.53 (3.47)  | 40-45 <sup>1,4</sup>     | 33 (46%)   | 13 (36%)  |
| Tibial inclination angle (degrees) | 8.68 (2.86)   | 0-5 <sup>5,6</sup>       | 9 (12.5%)  | 3 (4%)  |
| Hip extension angle (degrees)      | 3.95 (3.20)   | 8-11 <sup>7,8</sup>      | 5 (7%)   | 1 (1%)  |
| Forward trunk lean (degrees)       | 10.60 (3.97)  | 5-10 <sup>6</sup>        | -  | 15 (42%)  |
| Cadence (steps per minute)         | 170.67 (8.04) | 170-180 <sup>7</sup>     | -  | 18 (50%)  |
| Pelvic drop (degrees)              | 5.80 (2.28)   | 5-7 <sup>6</sup>         | 28 (39%)   | 2 (5.5%)  |
| Peak rear foot eversion (degrees)  | 11.72 (3.60)  | 6-8 <sup>1,3</sup>       | 9 (12.5%)  | 2 (5.5%)  |

IC= Initial Contact; MS= Midstance

## CONCLUSION

- This study is the first to describe 2D running kinematics in a healthy cohort of pediatric and adolescent runners.
- Healthy, competitive adolescent runners displayed running kinematics that were frequently outside of the range recommended for adult runners.
- It may be necessary to establish a separate set of kinematic recommendations for adolescent runners.
- Future studies should determine kinematic differences between healthy and injured adolescent runners.

## REFERENCES

- Dicharry J. Kinematics and kinetics of gait: From lab to clinic. *Clin Sports Med.* 2010;29(3):347-364.
- Heiderscheit B. *Orthopaedic Management of the Runner, Cyclist, and Swimmer: Biomechanics of Running.* In: *Orthopaedic Section Independent Study Course.* 23.1.4. Orthopaedic section, APTA; 2013.
- Nicola TL, Jewison DJ. The Anatomy and Biomechanics of Running. *Clin Sports Med.* 2012;31(2):187-201.
- Novacheck T. The biomechanics of running. *Gait Posture.* 1998;7(1):77-95. doi:10.3233/BMR-1995-5404
- Souza RB. An Evidence-Based Videotaped Running Biomechanics Analysis. *Phys Med Rehabil Clin N Am.* 2016;27(1):217-236.
- Pipkin A, Kotecki K, Hetzel S, Heiderscheit B. Reliability of a qualitative video analysis for running. *J Orthop Sports Phys Ther.* 2016;46(7):556-561.
- Brown K. *Return To Running.* Sports Physical Therapy Section, American Physical Therapy Association; 2012.
- Schache AG, Bennell KL, Blanch PD, Wrigley T V. The coordinated movement of the lumbo-pelvic-hip complex during running: A literature review. *Gait Posture.* 1999;10(1):30-47.