

Want to avoid running overuse injuries? Don't lean forward so much

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Credit: CC0 Public Domain

The ubiquitous overuse injuries that nag runners may stem from an unlikely culprit: how far you lean forward.

Trunk flexion, the angle at which a runner bends forward from the hip, can range wildly—runners have self-reported angles of approximately -2 degrees to upward of 25. A new study from the University of Colorado Denver (CU Denver) found that greater [trunk](#) flexion has significant impact on [stride](#) length, joint movements, and ground reaction forces. How you lean may be one of the contributors to your knee pain, medial tibial stress syndrome, or back pain.

"This was a pet peeve turned into a study," said Anna Warrener, Ph.D., lead author and assistant professor of anthropology at CU Denver. Warrener worked on the initial research during her postdoc fellowship with Daniel Lieberman, Ph.D., in the Department of Human Evolutionary Biology at Harvard University. "When [Lieberman] was out preparing for his marathons, he noticed other people leaning too far forward as they ran, which had so many implications for their lower limbs. Our study was built to find out what they were."

The study was published in *Human Movement Science*.

A new angle on overuse injuries

The head, arms and trunk constitute roughly 68% of total body mass. Small changes in trunk flexion have the potential to substantially alter lower-limb kinematics and ground reaction forces (GRF) during running.

To study the downstream effects, Warrener and her team recruited 23 injury-free, recreational runners between the ages of 18 and 23. They recorded each participant running 15-second trials at their self-selected trunk position and three others: a 10-, 20-, and a 30-degree angle of flexion. But to make the study work, they had to first figure out how to get each runner to bend at the right slant.

"We had to create a way in which we could reasonably force someone into a forward lean that didn't make them so uncomfortable that they changed everything about their gait," said Warrener. The team hung a lightweight, plastic dowel from the ceiling just above the runners' heads, moving it up or down, depending on the angle needed.

Contrary to the team's original hypothesis, the average stride length decreased 13 cm and stride frequency increased from 86.3 strides/min to 92.8 strides/min. Overstride relative to the hip increased 28%.

"The relationship between strike frequency and stride length surprised us," said Warrener. "We thought that the more you lean forward, your leg would need to extend further to keep your body mass from falling outside the support area. As a result, overstride and stride frequency would go up. The inverse was true. Stride length got shorter and stride rate increased."

Warrener believes this may be due to a decrease in the aerial phase (if they're not getting as much air time, runners will take shorter steps), which means leg swings quickened as a result of reduced forward movement.

"The act of swinging your leg is really expensive as you're running," said Warrener. "Swinging it faster as you lean forward may mean a higher locomotor cost."

Compared to the participants' natural trunk flexion, increased angles led to a more flexed hip and bent knee joint. A bigger lean also changed the runners' foot and lower limb position, leading to an increased impact of GRF on the body (rate of loading by 29%; vertical ground reaction force impact transients by 20%).

The combination of trunk flexion [angle](#), foot and leg placement, and

GRF variables, shows that excessive trunk flexion could be one cause of injurious running form and, according to Warrener, is key for understanding how diverse running forms optimize economy and performance.

"The big picture takeaway is that running is not all about what is happening from the trunk down—it's a whole-body experience," said Warrener. "Researchers should think about the downstream effects of trunk flexion when studying running biomechanics."

More information: Anna Warrener et al, The effect of trunk flexion angle on lower limb mechanics during running, *Human Movement Science* (2021). [DOI: 10.1016/j.humov.2021.102817](https://doi.org/10.1016/j.humov.2021.102817)

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