

Elbows key for walkers' efficiency

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Wandering through the Harvard campus one day in 2015, graduate student Andrew Yegian recalls how something unusual caught his eye. "I noticed a person running with straight arms," he explains. This really

stood out for Yegian, as runners usually bend the elbow, while walkers keep their arms straight, which made him wonder: "If straight arms are better for walking, why aren't they better for running, and vice versa?" he puzzled. Was there a trade-off between the cost of keeping the elbow bent and swinging the arm at the shoulder that could benefit runners? Could walkers conserve energy by keeping their swinging arms straight? Intrigued, Yegian and this thesis advisor, Dan Lieberman, decided to film athletes walking and running with straight and bent arms to find out why runners keep their arms bent while walkers let them swing loose. They publish their discovery that walking with a straight arm is much more efficient than walking with a bent arm in *Journal of Experimental Biology*.

Selecting eight undergraduate and graduate students—ranging from runners who dabbled twice a week to serious marathon competitors—to walk and run on a treadmill, Yegian says, "We wanted to study that kind of variation because bent arm running seems to be an almost universal behaviour, regardless of how much a person runs." Together with undergraduates Yanish Tucker and Stephen Gillinov, Yegian placed reflective markers on the athletes' shoulders, elbows and wrists before asking the runners to walk at $\sim 1.4 \text{ m s}^{-1}$ and run at $\sim 3 \text{ m s}^{-1}$ with straight and bent arms while they filmed the volunteers' movements in 3-D. "The hardest thing was running with straight arms," recalls Yegian, adding that all of the athletes found the movement strange. Then, Yegian and his undergraduate colleagues invited the volunteers to return 2 weeks later, so they could repeat the running and walking trials, but this time the athletes breathed through a mask to measure their [oxygen consumption](#), allowing the scientists to calculate their [energy consumption](#) as they moved with their arms in different positions.

Comparing the [energy costs](#), the team was impressed that holding the arms bent while walking increases the walkers' cost by 11%. And when they calculated the amount of effort required to keep the arm crooked, it

was clear that bending the elbow came at a cost, although this was slightly offset by the lower cost of swinging the relatively short arm. So, walking with straight arms is by far the most efficient option.

However, when the team compared the runners' [energy costs](#), the outcome was less clear. "We didn't find any evidence that the energy cost was different between arm postures when running," says Yegian, who had suspected that running with bent arms would be more efficient, 'since that's what almost everyone does,' he says.

So the jury is still out as to why runners bend their arms, although Yegian suspects that there must be some benefit that bears no relation to energetic costs, which keeps runners' arms pumping when pounding the streets.

More information: Andrew K. Yegian et al, Straight arm walking, bent arm running: gait-specific elbow angles, *The Journal of Experimental Biology* (2019). [DOI: 10.1242/jeb.197228](https://doi.org/10.1242/jeb.197228)

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