Arm swinging reduces the metabolic cost of running

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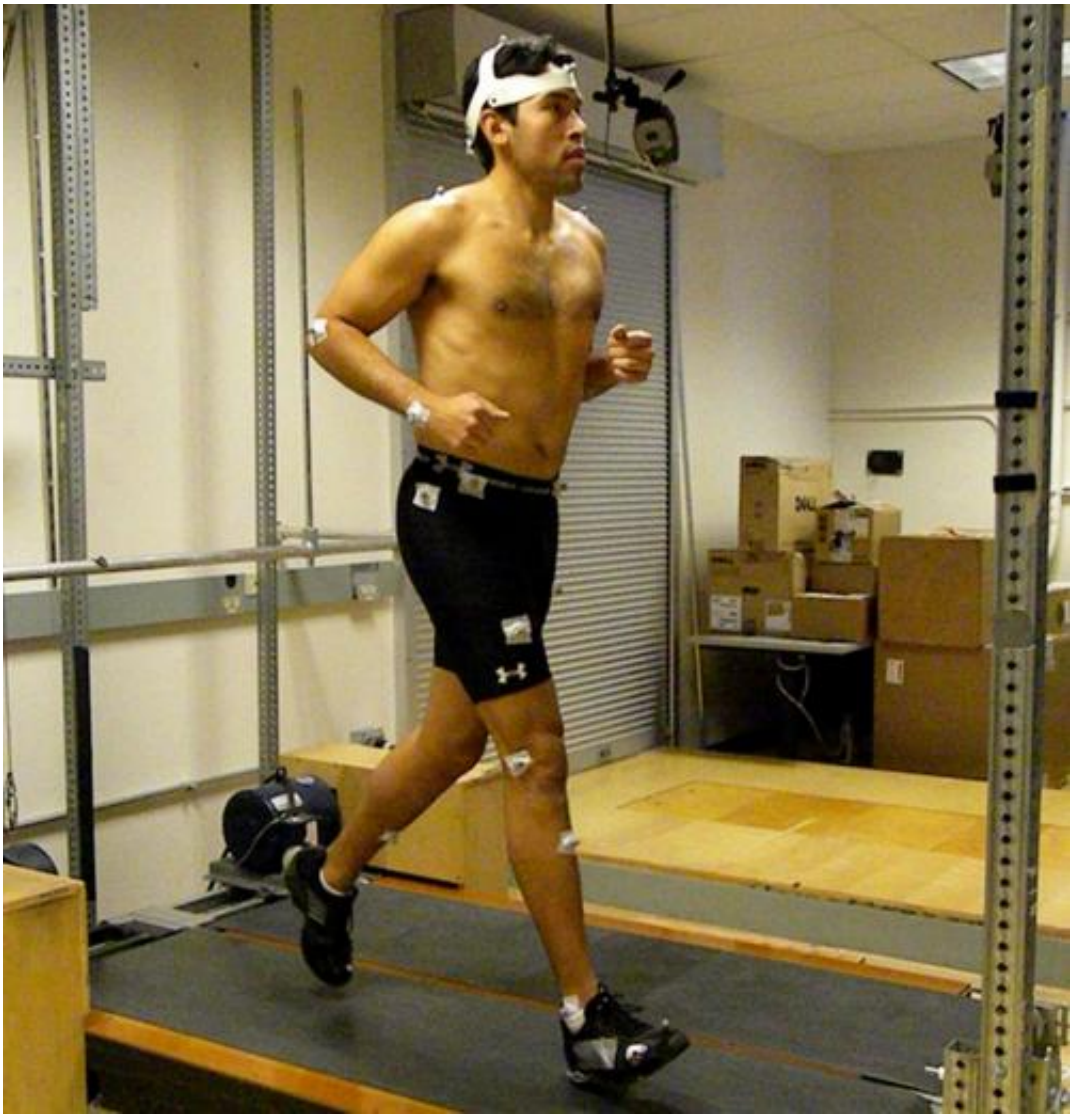

Arm swing reduces the metabolic cost of human running. Credit: Nicole E. Look.

Have you ever tried running without swinging your arms? It's not easy. Each step jars and it feels like hard work: but is it? Christopher Arellano, from Brown University, USA, says, 'We know from the literature that arm swinging plays an important role in balancing the motion of the swinging legs.' But it wasn't clear how the upper body movement affected the metabolic cost of running. And when Arellano and his thesis advisor, Rodger Kram, from the University of Colorado, Boulder, USA, looked into the literature to find out whether the metabolic effects of arm swinging had been measured, they found few studies and those that they did find did not agree. With the jury out, Arellano and Kram decided to embark on a thorough study of the impact of arm swinging on the metabolic cost of running.

Fortunately, when Arellano initiated the study he was based in Boulder, which is home to a community of dedicated runners: 'It is never a problem to recruit people', he laughs. Having calculated that he required 13 runners to generate sufficient data, Arellano selected eight men and five women who were all committed runners. Inviting each runner to the lab, Arellano asked them to run normally on a treadmill for 7 min as he measured their oxygen consumption rates and the amount of carbon dioxide that they exhaled. Then he asked them to run without swinging their arms by holding the arms loosely behind the back, crossing the arms across the chest, and holding the hands on the top of the head. 'I think everyone conceded that the most challenging run was the one with the hands on the top of the head,' chuckles Arellano, who recalls the runners complaining about how tired their arms were at the end of the session.

Having measured the athletes' oxygen consumption rates and carbon dioxide production, Arellano then calculated the metabolic rates of each runner when they were swinging the arms and holding them in all three positions. Comparing the four metabolic rates for each individual, Arellano and Kram could see that swinging the arms reduced the

runners' energy costs by 3% (relative to when they held their arms behind their backs). Arm swinging also saved an impressive 13% compared with when they held their hands on their heads. And when Arellano analysed the athletes' shoulder movements, he could clearly see that the runners had compensated for the loss of the counterbalancing swinging arms by increasing the amount that they swivelled the upper body. 'Whether they knew it or not, they all compensated in a very similar way by increasing the amplitude of their torso rotation', recalls Arellano.

Swinging the arms clearly saves energy for runners, and helps to minimise the amount that we rotate the body while swinging our legs, which led Arellano and Kram to wonder whether the metabolic benefits of arm swinging outweigh the cost of carrying the limbs. Explaining that they were interested in how metabolic energy is partitioned between different aspects of an activity, Arellano says, 'The arms weigh about 10% of the body, so if we took them away we could hypothetically save 10% of the metabolic cost of running, but at the same time you wouldn't have any mass to counteract the swinging of the legs, so running would be more difficult to stabilise.' And Arellano is keen to follow up on two of the runners whose running costs were unimproved by moving their arms. 'Either they are not getting the benefit of arm swinging or somehow they modified their running style to keep the metabolic costs the same', he says.

More information: Arellano, C. J. and Kram, R. (2014). "The metabolic cost of human running: is swinging the arms worth it?" *J. Exp. Biol.* 217, 2456-2461. jeb.biologists.org/content/217/14/2456.abstract

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