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Kids are clumsy runners because they are small

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To the untrained eye, kids just look like scaled-down adults. But take a closer look at the way that they move and a toddler's stiff-legged waddle is completely different from an adult's fluid run. Perceived wisdom held that small children were simply immature versions of their parents: 'Some scientists see a young child appearing to walk and run uneconomically and then attribute it to being under developed', explains Jim Usherwood from the Royal Veterinary College, UK. But when he took a closer look at the way children move, Usherwood questioned this dogma and suspected that he would need to take a completely new approach to try to understand the factors that account for kids' clumsy movements. Wondering whether the children's diminutive stature was responsible for their lack of grace, Usherwood developed a new theory about the way that children run and he publishes his discovery that children's short legs struggle to find enough time to do the work to push them into the air while running in *Journal of Experimental Biology*.

Recalling that many of his friends had children of the appropriate size at the time at the time that he was puzzling over the question, Usherwood and Tatjana Hubel recruited 18 children - including two of Usherwood's own daughters - ranging in age from 1.1 to 4.7 years, to find out more about their movements. The duo used a camera system to track the position of reflective dots placed at specific locations on the children's limbs as they moved at various speeds along a track, while also measuring the forces that they exerted on the floor. Usherwood adds, 'We were careful not to tell them what gait to use', explaining that Hubel would ask the children to either match their parent's speed, or to go

faster or slower, to ensure that she did not bias their movements.

However, having collected the data, the duo then ran into trouble. No matter how hard Hubel tried, the measurements did not stack up. When she attempted to put all of them onto the same size scale - to see how well they agreed with the predictions of the simple models that account for how adults walk and run - one factor kept on confounding her calculations: time. Wracking his brains, Usherwood realised that the mechanical models - some of which are based on inverted pendulums - missed out one key physiological factor: muscle. 'You activate the muscles and there is a physiological cost to activating it', Usherwood says, but this was not accounted for in the models based solely on the physics of movement. He adds that kids' legs are shorter than adults', allowing them less time to push up and away from the ground, providing their muscles with less time to contract and generate the power that they need to move, leaving their feet on the ground for a longer proportion of each stride than the adults'. 'You can see that by watching a 3 year old running, they barely get off the ground', he says. By calculating the amount of muscle that is necessary to generate the movements, Usherwood realised that he could deal with the troublesome time factor.

Building a model that represented the moving people as a single piston that was the length of the individual's leg, Usherwood calculated the amount of muscle required to produce the power necessary to propel the individuals along at the speeds that he and Hubel had measured. The new model successfully reproduced the youngsters' and adults' movements.

So kids move the way that they do simply because they are smaller than adults and their short limbs do not have enough time to produce the high powers needed to lift them into the air when running, not because they are training to be as good as adults.

More information: Hubel, T. Y. and Usherwood, J. R. (2015).

Children and adults minimise activated muscle volume by selecting gait parameters that balance gross mechanical power and work demands. J. Exp. Biol. 218, 2830-2839, jeb.biologists.org/lookup/doi/10.1242/jeb.122135