



The weekly recap of what's going on in the World of Biomechanics!

Effect of asymmetric crank arm lengths on performance-related variables in cyclists with an anatomical lower limb length discrepancy

In this week's recap of what is going on in the world of biomechanics, we share a quick look at a biomechanical aspect in bicycle design: The length of the crank arms. Enjoy the read!

The main objective in bicycle design for athletes might be quite straight forward: Improving biomechanics to increase performance while maintaining the cyclist's health.

Increasing performance could be broken down into higher torque onto the chain wheel with the same (or less) physiological exertion. As we know, torque equals force times lever, and assuming we can't change the force output of the athlete (since that would be called training, and we don't do this here), we are left with optimizing the lever.

Here, the length of the crank arms is of interest as they act as these lever arms to generate torque that acts upon the chain. Usually, lengths from 165mm to 180mm are available on the market and are sold in sets of two - resulting in a symmetrical setup. However, humans tend to be asymmetrical if you look close enough, and investigators found that 20% in a population of 1619 individuals showed lower limb inequality greater than 9mm [1].

To address this issue, cyclists in the past have been increasing their sole thickness or used spacers between the shoe and the pedal to decrease joint extension. Although it has been shown that this can improve gross efficiency [2], these measures result in higher joint flexion since the limb is raised in the entire pedaling cycle. This might lead to problems for athletes with poor flexibility of the hips and hamstrings [3].

A recent case study by Geoffrey Millour, Sebastien Duc, Frederic Puel & William Bertucci tested the concept of asymmetrical pedal setups with three male cyclists, each with a lower limb length difference ranging from 10 mm to 28 mm. The subjects performed three test



sessions with asymmetrical setups, every session consisting of one 8 min pedaling at 60% of maximal power output, two 10 s sprints and one 30 s Wingate test (that's a frequently used anaerobic exercise test). The group recorded power output, heart rate, oxygen consumption, gross efficiency, cycling economy and hip, knee, and ankle 2D-kinematics. Furthermore perceived exertion and perceived comfort were evaluated.

First off, the shortened crank arm did reduce the knee and ankle extension as well as hip and knee ROM. Secondly, the maximal power output improved while the perceived exertion was reduced. Also, perceived comfort improved. However, the physiological parameters did not show significant differences between the symmetric and asymmetric setup. Here, results might be clearer with a larger sample group.

To us, this case study is interesting since it shows how we tend to assume perfect human symmetry in ergonomic design, although we know almost nobody is that symmetric. Give [the paper a read](#) if you are interested in more details, it's open access!

Millour, G., Duc, S., Puel, F. *et al.* Effect of asymmetric crank arm lengths on performance-related variables in cyclists with an anatomical lower limb length discrepancy. *Sports Eng* **23**, 14 (2020). <https://doi.org/10.1007/s12283-020-00327-w>

Further References

[1] Knutson GA (2005) Anatomic and functional leg-length inequality: a review and recommendation for clinical decision-making. Part I, anatomic leg-length inequality: prevalence, magnitude, effects and clinical significance. *Chiropr Osteopat* 13(11):1-10. <https://doi.org/10.1186/1746-1340-13-1>

[2] Bouillod A, Retali M, Soto-Romero G et al (2017) Acute effect of biomechanical foot orthotics on gross efficiency in cyclists affected by an anatomic asymmetry in time trial position. *Comput Method Biomech* 20(Sup1):23-24. <https://doi.org/10.1080/10255842.2017.1382842>

[3] Wadsworth DJ, Weinrauch P (2019) The role of a bike fit in cyclists with hip pain. A clinical



commentary. Int J Sports Phys 14(3):468. <https://doi.org/10.26603/ijspt20190468>