

How low can you go – exploring the balance between aerodynamic advantages and restrictions related to reducing the torso-hip angle

Introduction: Lowering of the upper body position to optimize cycling time trial (TT) performance is a balance between aerodynamic benefits from reducing the rider's frontal area and the reported detrimental effects of decreasing the hip-torso angle on exercise economy and power output. **Methods:** To explore this issue in trained athletes and across positions relevant for elite TT, racing positions for international (top-10 world championships [WC] TT finishers), and national elite (10 male) cyclists were analyzed and lab studies on the national group were completed to evaluate effects on exercise economy, muscle oxygenation and perceived exertion for their habitual position, respectively, the range of racing positions observed for both groups of elite TT riders. **Results:** Torso-horizontal angle for top-10 WC finishers ranged from 4-12°, while the national elite TT racing position were in the range from 8 to 18°. For the lowest observed and lab-investigated position (4° torso-angle), perceived exertion was aggravated compared to the more upright 12° and 20° positions and higher than scores for rider's habitual position. However, there was no difference in overall energy expenditure, delta exercise efficiency or measures of muscle oxygenation across the investigated range of positions. **Conclusion:** These observations indicate that elite time trial cyclists may adopt a very low (and aerodynamic attractive) position without compromising exercise economy or muscle oxygen delivery. However, the elevated exertion expressed for the lowest position indicate that other (individual/not accounted for) factors may affect and potentially compromise the ability to adapt to very low racing positions.

Keywords: *exercise economy; torso angle; aerodynamics; time trial*