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# Relationship between preferred saddle height and pedalling kinematics in professional cyclists

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## Purpose:

Proper saddle height in cycling can improve health, comfort, and performance (Millour et al. 2019). Methods based on knee angle (KA) for saddle height adjustment are frequently employed (Ferrer-Roca et al. 2011). They are considered accurate because they consider individual differences in thigh, shank, and foot length (Bini and Hume 2016). Ferrer-Roca et al. (2011) advocate KA between 30° and 40° during maximum knee extension while pedalling to prevent injuries. However, this method does not consider ankle angle (AA) which can vary considerably according to the individual pedalling technique (Peveler et al. 2012).

The purpose of this study was to analyse lower limb joint angle of professional cyclists in their preferred saddle height. The hypothesis was that AA should be taken into consideration for an accurate adjustment of saddle height in cycling.

## Methods:

Seventeen professional cyclists volunteered for this experiment (Mean ± SD: 28 ± 5 years old, 1.80 ± 0.05 m, 70 ± 7 kg). A 1<sup>st</sup> step was to optimise cycling cleat position with a ML Cleat® device (Morphologics, Saint-Malo, France) and to adjust saddle and handlebar positioning according to the Morphologics ergonomist advices. Then, all the cyclists have 1 month to validate this position or to modify it according to this comfort's feeling. In a 2<sup>nd</sup> step, the cyclists performed a submaximal pedalling test of 3 min at 150 W and 80 rpm on their personal road bike which was mounted on an Elite Turno ergometer® (Elite, Fontaniva, Italy) enabling to control break resistance. To measure KA, AA, and hip angle (HA) during maximum knee extension (Figure 1), markers were placed on the left side of each participant on greater trochanter, lateral femoral epicondyle, lateral malleolus, and 5<sup>th</sup> metatarsal head. A high-resolution digital camera (Go Pro Hero 3, San Mateo, California, USA) was positioned at 4 m and perpendicular to the cyclists. Joint angles data of 10 consecutive pedalling cycles were analysed using kinematic analysis software (Kinovea V0.8.24). A correction of parallax and a correction of distortion were made with this software.

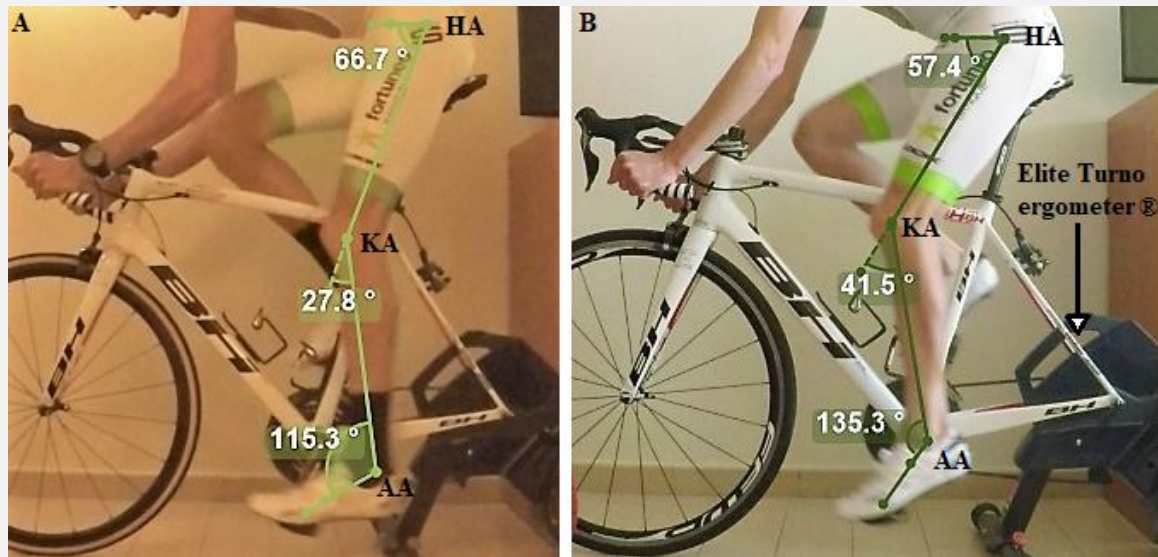
## Results:

The results showed that the means of KA, AA, and HA were 38.0 ± 4.5°, 124.7 ± 5.2°, and 59.2 ± 3.8°, respectively. Although this mean of KA was in the range of 30°-40°, we can observe a large discrepancy between the cyclists and 5 of them had a KA outside the optimal range advocated by Ferrer-Rocca et al. (2011). Figure 2 shows that KA was positively correlated to AA ( $r = 0.57$ ,  $p < 0.01$ ) but negatively to HA ( $r = 0.73$ ,  $p < 0.01$ ).

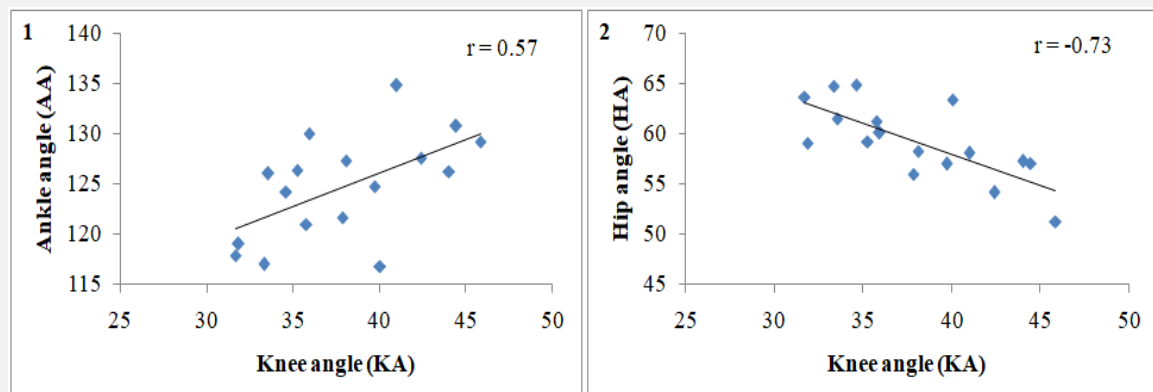
## Conclusion:

Our results suggest that professional cyclists can exhibit different pedalling kinematic patterns. Athletes with higher KA present lower HA and important plantarflexion during maximum knee extension. Conversely, athletes with lower KA exhibit higher HA and large dorsiflexion during maximum knee extension. These results are in accordance with Ryan and Gregor (1992) who showed a strong inter-subject variability in pedalling kinematics of well-trained cyclists. Peveler et al. (2012) suggested that optimisation of the cycling position must take into account individual anthropometry as well as pedalling technique, and notably the foot orientation during pedalling. Cyclists who pedal with an important plantarflexion during maximum knee extension may use higher KA than those pedalling with a large dorsiflexion. This study suggests that saddle height adjustment optimisation should take into consideration each rider's pedalling technique, notably foot orientation, and that KA outside optimal Ferrer-Roca range is not necessarily related to a poor saddle height adjustment.





**Figure 1.** Typical values of hip angle (HA), knee angle (KA) and ankle angle (AA) measured while pedalling during maximal knee extension in two professional cyclists (A: Extended knee/Flexed ankle; B: Flexed knee/Extended ankle)



**Figure 2.** Relationship between knee angle (KA) and ankle angle (AA) [1] and between knee angle (KA) and hip angle (HA) [2]

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