Pedal Smarter, Not Harder: How Crank Arm Length Affects Cycling Mechanics and Performance Using Augmented Reality

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INTRODUCTION

- Among the various factors influencing cycling performance, crank arm length (CAL) plays a significant role by affecting joint kinetics, kinematics, and overall efficiency.
- While previous studies have examined its effects on cycling power and performance metrics, further research is needed to simulate real-world conditions rather than focusing on *extreme CAL variations or short-duration trials*.
- Growing interest and popularity in indoor cycling with augmented reality (AR) software is driven by several benefits (e.g., weather independence, the ability to simulate real roads, and the capability to track numerous cycling metrics).
- The purpose of this study was to investigate how different CALs affect joint kinematics, time to completion, and key cycling metrics using AR cycling software and smart bike.

METHODS

	Age (yrs.)	Height (m)	BM (kg)	BMI (kg/m²)	Lower Limb Length (cm)
Participants *(6 M, 6 F)*	21.2 ± 1.5	1.73 ± 0.1	77.3 ± 18.5	25.7 ± 4.5	89.5 ± 7.1

- Participants completed a virtual cycling route (11.65 km, 34.1 m elevation) on three separate occasions, each using different CALs (165, 170, and 175 mm) using smart Bike (KICKR, Wahoo) and AR software (Rouvy).
- Video captured in the sagittal plane, focusing on the lower legs, using a camera (Sony FDR-AX53). Knee joint kinematics analyzed using 2D video analysis software (Dartfish).

METHODS (Cont.)

- Participants were instructed to maintain a "somewhat hard" perceived exertion (RPE) throughout each trial.
- Repeated measures ANOVA analyzed the effects of CAL on knee joint kinematics, cadence (rpm), time to completion (min), power (W), and pedal speed (m/s).

Figure 1. Data collection setup showcasing the Wahoo KICKR BIKE, video camera, and laptop for AR cycling software and kinematic analysis.

RESULTS

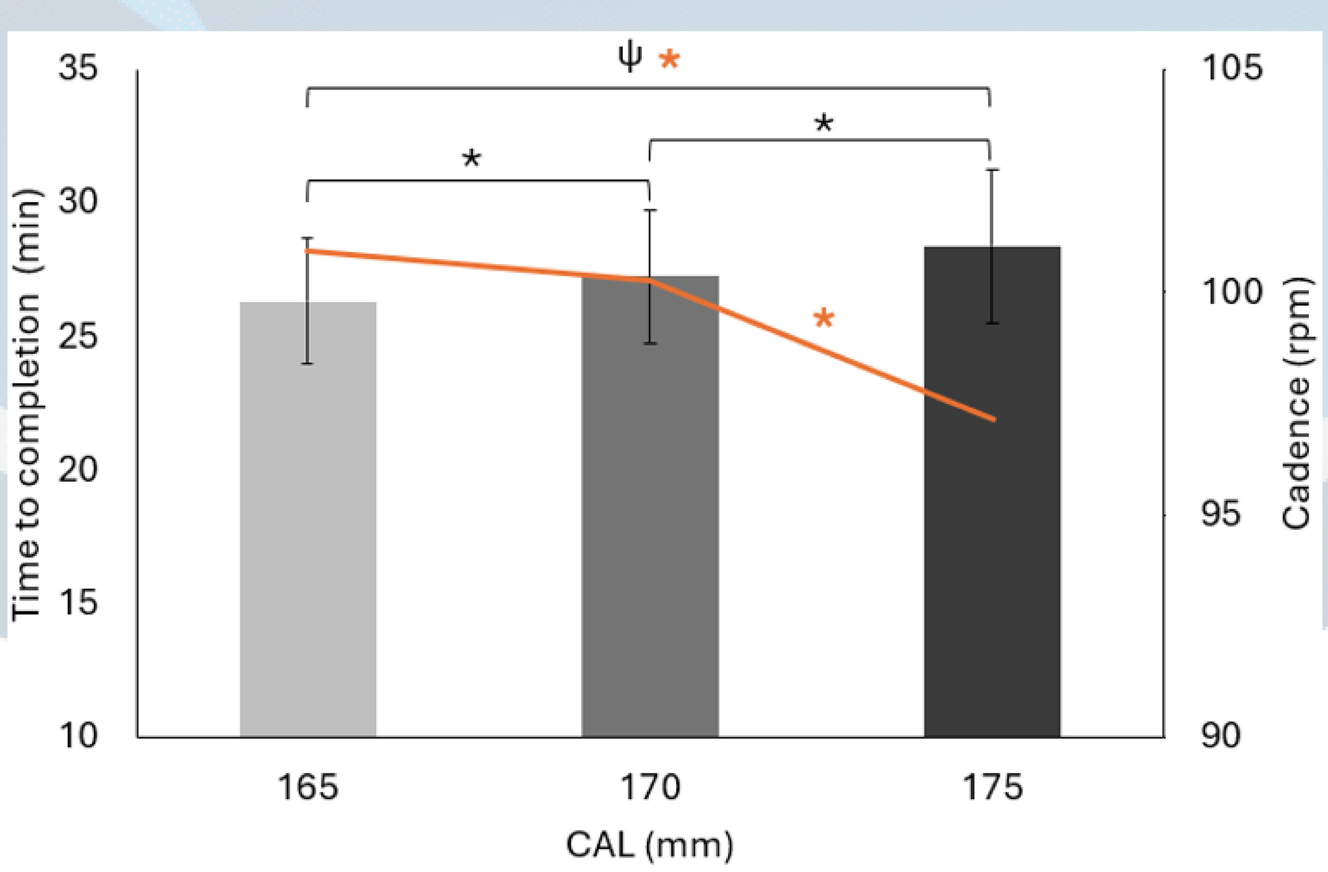

Figure 2. Cycling TT performance (mins) and cadence (rpm) depending on CALs.
Note. * denote significant difference ($p < 0.05$)
ψ denote significant differences ($p < 0.01$)

RESULTS

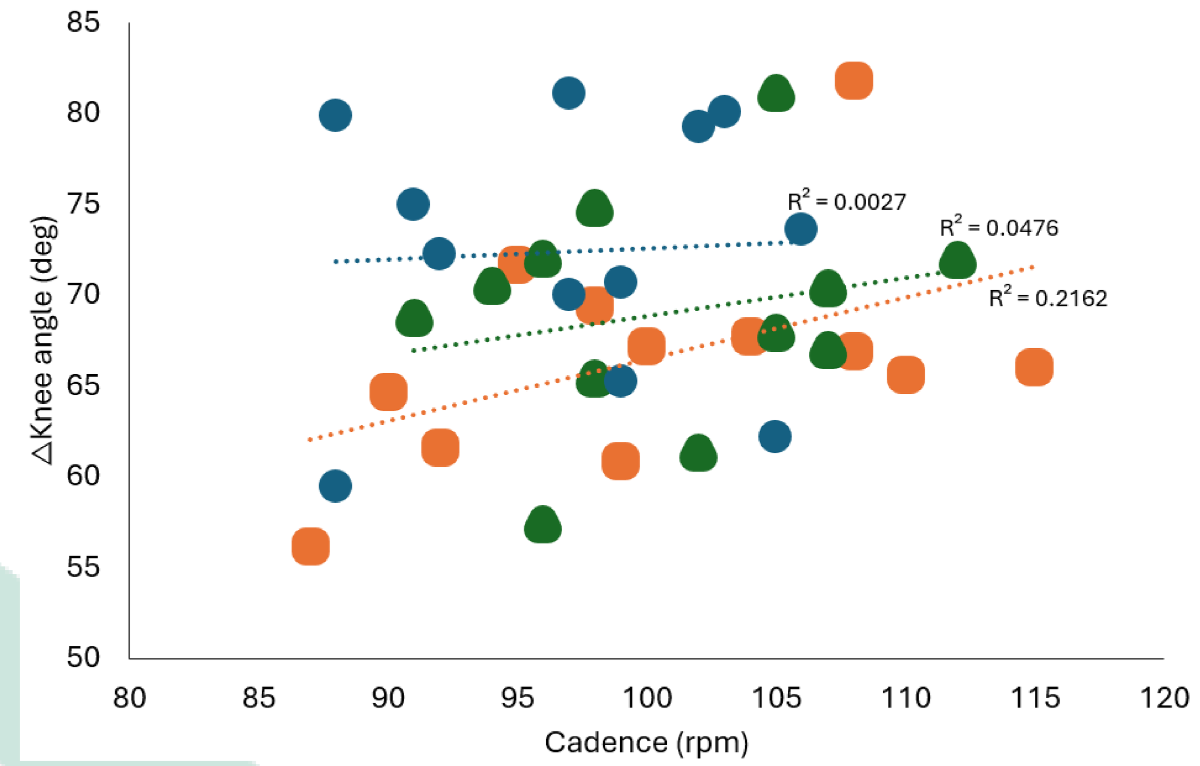

Figure 3. Relationship between △knee angle and cadence.
Note. blue circles = 175 mm CAL, green triangles = 170 mm CAL, and orange squares = 165 mm CAL.

- CAL significantly influenced joint kinematics (i.e., knee angular displacement, velocity, and acceleration; $p < 0.005$), cadence ($p < 0.05$), and time to completion ($p < 0.001$).
  - *Specifically, as CAL increased, cadence decreased, while shorter CALs resulted in faster completion times.*
- CAL had no significant effect on cycling power ($p = 0.54$) or pedal speed ($p = 0.16$).

PRACTICAL APPLICATIONS

- Cyclists and coaches should consider CAL's effects on joint kinematics and cadence for optimal performance. AR software and smart bike proves useful for simulating real-world cycling conditions, supporting more precise equipment selection and training strategies.

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