

Conference Abstract

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Are an elite pursuit cyclist's anthropometrics, flexibility and standing posture associated with their cycling position?

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1 Introduction

In pursuit cycling, riders adopt an aerodynamic position with a horizontal torso to reduce drag and improve performance. However, the individual characteristics that influence a cyclist's pursuit position or ability to achieve a particular position are unknown. Knowledge of such information would

assist in talent profiling, bike fitting practice, and training interventions. A bike fit that is specific to the individual and their competitive requirements is critical to performance (Swart & Holliday, 2019). Individual characteristics, such as leg length and hamstring flexibility, are typically considered (Holliday & Swart, 2021), with flexibility and standing posture potentially also influencing cycling kinematics and



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posture (Muyor et al., 2011 & 2022). Therefore, the aim of this study was to investigate whether a pursuit cyclist's anthropometrics, flexibility and standing posture are correlated with their bicycle set-up and riding posture.

2 Material and Methods

Ten elite international level pursuit cyclists (7 males, 3 females, 20.3 ± 2.6 years; 1.76 ± 0.08 m; 71.9 ± 7.6 kg) provided written informed consent before participating in this study. Stature, trochanteric height, and relative arm (acromion to third fingertip) and leg length (trochanteric height) as a percentage of stature were recorded. In addition, each cyclist's absolute (middle saddle to pedal spindle at bottom dead centre), and relative (as a percentage of trochanteric height), saddle height was recorded. Saddle setback and saddle to pad drop were recorded as a percentage of saddle height, while saddle to pad reach was measured as a percentage of stature (Holliday & Swart, 2021).

Participants then completed a 3-minute maximal time-trial in their aerodynamically optimised pursuit cycling position on an SRM ergometer. One high-speed video camera was used to capture full body sagittal plane kinematics from the middle 40 pedal revolutions using 14 retroreflective markers (Williams et al., 2025). For each kinematic variable, the mean angle was calculated for each revolution and the overall mean across all revolutions was recorded (Table 1). Participants then performed a fingertip to floor distance test (FFD) to assess lumbopelvic flexibility (Holliday & Swart, 2021) and a shoulder flexion test. For the latter test, the cyclists

stood with elbows and palms touching and were instructed to reach upwards as far as possible while greater trochanter, shoulder joint centre and elbow lateral epicondyle markers were recorded to calculate maximum shoulder angle. Standing sacral tilt, lumbar curvature and thoracic curvature were also captured in a separate trial, using the six retroreflective markers along the spine (Muyor et al., 2022).

Table 1. Anthropometrics, flexibility, standing posture, bicycle measurements and on-bike kinematics.

Variable	Mean $\pm$ SD	Range
Stature (cm)	176.5 ± 7.9	161.2, 185.6
Trochanteric Height (cm)	88.5 ± 3.8	82.0, 93.4
Leg Length (%)	50.2 ± 1.6	47.3, 52.8
Arm Length (%)	43.6 ± 1.2	41.4, 44.9
FFD (cm)	10.0 ± 6.3	0.3, 17.7
Shoulder Flexion ($^{\circ}$)	121.7 ± 11.1	104.2, 137.4
Standing Sacral Tilt ($^{\circ}$)	19.0 ± 8.8	3.7, 35.3
Standing Lumbar Curvature ($^{\circ}$)	-37.5 ± 12.0	-60.5, -20.0
Standing Thoracic Curvature ($^{\circ}$)	41.4 ± 11.4	21.5, 62.3
Saddle Height (cm)	88.4 ± 3.9	80.6, 93.7
Saddle Height (%)	99.9 ± 2.9	94.5, 103.4
Saddle Setback (%)	4.3 ± 1.9	0.9, 7.7
Pad Reach (%)	26.8 ± 1.1	25.0, 28.5
Pad Drop (%)	20.0 ± 2.3	17.2, 23.4
Hip Angle ($^{\circ}$)	94.3 ± 7.1	81.7, 101.8
Knee Angle ($^{\circ}$)	98.8 ± 4.7	92.6, 104.9
Ankle Angle ($^{\circ}$)	120.1 ± 3.5	115.4, 125.4
Torso Angle ($^{\circ}$)	9.0 ± 2.9	4.9, 14.1
Shoulder Angle ($^{\circ}$)	80.8 ± 5.1	73.6, 89.0
Elbow Angle ($^{\circ}$)	110.2 ± 4.8	98.7, 115.8
Sacral Tilt ($^{\circ}$)	48.8 ± 3.9	41.2, 55.6
Lumbar Curvature ($^{\circ}$)	31.4 ± 7.8	18.4, 40.5
Thoracic Curvature ($^{\circ}$)	38.9 ± 12.8	20.1, 55.1

For the statistical analysis, a Pearson's correlation matrix was created to investigate the associations between anthropometrics, flexibility and standing posture, and bicycle set-up measurements and on-bike kinematics. Processing and analysis were completed in Python (Version 3.12, Spyder IDE).

3 Results

Table 2. Significant correlations ($p < 0.05$) between individual characteristics and cycling position.

Variable 1	Variable 2	r	p
Stature (cm)	Saddle Height (cm)	0.910	< 0.001
	Saddle Setback (%)	0.725	0.018
	Elbow Angle (°)	0.681	0.030
Trochanteric Height (cm)	Saddle Height (cm)	0.768	0.009
	Saddle Setback (%)	0.647	0.043
Leg Length (%)	Saddle Height (%)	-0.826	0.003
	Sacral Tilt (°)	0.664	0.036
Arm Length (%)	Reach (%)	0.753	0.012
	Sacral Tilt (°)	0.693	0.026
FFD (cm)	Ankle Angle (°)	-0.736	0.015
	Thoracic Curvature (°)	-0.760	0.011
Shoulder Flexion (°)	Sacral Tilt (°)	-0.722	0.018
Standing Lumbar Curvature (°)	Ankle Angle (°)	-0.665	0.036
	Thoracic Curvature (°)	-0.652	0.041

The results showed that select individual characteristics are significantly associated with pursuit bicycle configuration and on-bike kinematics. As expected, trochanteric height – along with stature – was significantly associated with saddle height (Holliday & Swart, 2021) and saddle setback (Table 2). However, relative leg length was negatively correlated with relative saddle height. Although riders with longer legs used a greater saddle height, those with long legs relative to their height used a low saddle relative to their leg length – and saddle height was more correlated to stature. Riders with relatively longer legs might be required to use a lower saddle to have a comparable handlebar position and aerodynamic drag to riders with relatively shorter legs. Relative leg and arm lengths were both positively associated with sacral tilt. Longer legs relative to height implies a relatively short

torso, and because relative arm and leg length were positively correlated ($r = 0.740$, $p = 0.014$), it can be assumed that those with a short torso also had longer arms. Riders with a relatively short torso might require increased anterior sacral tilt to achieve an equivalent torso angle to those with a longer torso, as less torso flexion can be achieved through spinal curvature alone. Relative arm length was also positively associated with pad reach. This is intuitive in an upright posture where the hands contact hoods, but interestingly this held true with aerodynamic handlebars.

A greater FFD was associated with reduced ankle plantarflexion and thoracic curvature. Riders with a more flexible posterior chain might prefer more dorsiflexion as they have greater knee extension range with a horizontal torso. However, ankle joint angle is also influenced by saddle position and lower limb proportions. Also, reduced thoracic curvature (a flatter back) presents an aerodynamic advantage (Kyle, 2003), so increasing lumbopelvic flexibility could be recommended for reduced drag. Similarly to a greater FFD, less standing lumbar curvature (lordosis) was associated with a reduced ankle angle and thoracic curvature, suggesting that greater standing curvature is linked to poorer lumbopelvic flexibility. A greater maximum shoulder flexion was associated with less on bike sacral tilt, showing riders with more shoulder flexibility achieved a low aerodynamic position with less anterior sacral tilt.

4 Next Steps and Potential Applications

The findings have implications for bike fitting and training interventions in pursuit cycling, however there are limitations that require consideration. As the participants were elite pursuit cyclists, a relatively small sample size was included limiting the statistical power of the results. In addition, inferences made to aerodynamic drag improvements are based on previous research not direct drag force measurement. Therefore, future research should expand on this study with data collected from a larger sample of cyclists with a measurement of aerodynamic drag. While more work is required, the results suggest that in a pursuit cycling position, saddle height should account for stature rather than relative leg length, while reach should account for relative arm length. Also, to improve aerodynamic posture, practitioners should prescribe exercises to improve lumbopelvic flexibility for a flatter back profile and shoulder flexion range of motion where anterior sacral tilt is limited.

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