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JSC | Journal of Science & Cycling
Breakthroughs in Cycling & Triathlon Sciences

Conference Abstract
Science and Cycling Conference, Barcelona 2026

# Kinematic analysis at different pedalling intensities and slopes in competitive cross-country athletes preliminary results

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**Received:** 7 April 2026 **Accepted:** 17 April 2026 **Published:** 4 November 2026

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**Keywords**

cycling biomechanics; pedalling kinematic; bike fitting; cross-country

## 1 Abstract

### 1.1 Background

To enhance the cyclist's efficiency, the bike fitting is carried out with the goal of improving performance (1). Although bike fitting is usually done without simulating any climb, slopes can still impact the cyclist's pedalling. The aim of this study was to evaluate the three-dimensional kinematics at different pedalling intensities and slopes in competitive cyclists.

### 1.2 Methods

Eleven off-road cyclists were recruited. Firstly, each participant completed an incremental test with a power increase of 15 W per minute until exhaustion. During the test, a gas analyser (MetaLyzer 3B) was used to assess

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the VO2max. Then, 48 h later, each cyclist performed 4 trials of 2 minutes at different intensities (65%, 75%, 85%, 95% of the VO2max) and the bike set at a 0° slope with a 3-minute rest between trials. Subsequently, the same 4 trials were repeated with a 10° slope. For the kinematic analysis, a 3D motion capture system (STT Systems) was used (2). For statistical analysis, the following parameters were considered: ankle flexion (AF), knee flexion (KF), hip flexion (HF), vertical hip oscillations (VHO) and shoulder flexion (SF).

### 1.3 Results

Regarding KF, we found significant differences across intensities ($p=0.047$) and between slopes ($p=0.007$). It had found a significant difference in VHO in the interaction across intensities and slopes ($p=0.020$). A significant difference in SF was observed across intensities ($p<.001$). We found no significant difference in NSI in AK, KF, HF, and SF. The NSI of the VHO increased significantly compared to trials at 65% and 85%.

### 1.4 Conclusions

Our results suggest that both slope and intensity influence three-dimensional kinematic values and the bilateral symmetry index, key parameters for movement efficiency. For this reason, and given the physiological demands of cross-country racing, we recommend that cycling biomechanics professionals consider slope and intensity when performing bicycle biomechanical measurements.

## References


1. Holliday W, Theo R, Fisher J, Swart J. Cycling: joint kinematics and muscle activity during differing intensities. Sports Biomech. 2023;22(5):660-74.
2. Millour G, Velásquez AT, Domingue F. A literature overview of modern biomechanical-based technologies for bike-fitting professionals and coaches. International Journal of Sports Science & Coaching. 2023;18(1):292-303.