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The effect of cycling position on the lower-limb kinematics during the run in triathletes

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1. Introduction

Triathlon is a multisport in which the transition between the phases of a triathlon is a unique feature of this sport. It has already been showed that the run session after cycling may affect performance but also injury risk. Indeed, up to 70% of triathletes have been seen to run at speeds 10% below their normal running speed over the first 500–1000m following cycling in an Olympic triathlon. Also, Rendos et al. (2013) showed that 30 min cycling induces changes in running kinematics of the pelvis, and hip, that may increase the risk for lower extremity injuries. In particular, these authors reported an increase in anterior pelvic tilt and a reduced hip extension in running following cycling. They emitted the hypothesis that those changes were related to the position on the bike causing tightness in the anterior musculature.

Recently, Dewolf and colleagues (Dewolf & De Jaeger, 2015; Dewolf, Mesquita, & De Jaeger, 2022) suggested that a change of the overall lower limb stiffness affects significantly the angle of maximal hip extension and anterior pelvic tilt. Because of the reported changes in joint stiffness during running following cycling (Sayers, 2012), one may expect that the modification observed in Rendos et al. (2013) are not only related to the position on the bike. To test the contribution of cycling position, the run prior and post cycling was evaluated in triathletes divided into two groups: one group with a more flexed posture on the bike, and the other one with a straighter posture. The effect of cycling on pelvic and hip kinematics were compared before and after the cycling effort in the two groups. We hypothesized that the modification observed after a 30 min cycling effort will not be influenced by the position on the bike.

2. Methods

Twenty-two triathletes (age: 24.91±5.26 y, mass: 68.09±7.35 kg; height: 1.77±0.08 m, 19 males) with more than 2 years of experience in triathlon competition participated to the study. Informed written consent was obtained and the study followed the guidelines of the Declaration of Helsinki. All procedures were accepted by the local ethics committee.

After a 5 minutes warm-up running on a treadmill at self-selected speed, the participants ran 5 minutes at a speed corresponding to an intensity of 14-17 on the RPE Borg's scale (average running speed: 15.09±1.74 km/h). After the 5 minutes of running, participants were asked to perform a 30 min effort on their own bike fixed on a home trainer, at the same intensity (14-17, monitored every 5 minutes by an experimenter). Immediately following cycling, subjects were asked to run 15 min at the same speed than the previous running trial. Half of the subject did the cycling in a "time trial position" using handlebar extension (more flexed) whereas the other half did it in a upright position (less flexed). The transition time was always less than 1 minute, except for 3 subjects for whom the repositioning of markers increased the transition to approximately 4 minutes.

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Bilateral, full-body 3D kinematics were captured at 250 Hz with a 16-camera system placed around the treadmill. Participants were equipped with 21 retro-reflective markers glued onto the skin. The orientation of the pelvis and femur during running were measured from the markers placed on the right side on the anterior superior iliac spine (ASIS), the greater trochanter (GT), and the lateral femoral condyle (LFC). 3D coordinates of the markers were measured using the Qualysis software. The anterior-posterior pelvic tilt and the thigh flexion-extension were evaluated, respectively, as the angle of the ASIS-GT segment with horizontal and as the angle of the GT-LFC segment with vertical. For each trial, data were collected for 15 seconds. The maximum of anterior pelvic tilt, of thigh flexion and extension were averaged over at least 15 consecutive strides using a custom-made program implemented in MATLAB.

To compare the kinematics of running before and after cycling, the differences between post and pre were computed. Then, a one-way ANOVA was used to evaluate the effect of cycling position on the $\Delta_{post\text{-}pre}$ of maximal anterior pelvic tilt, thigh flexion and thigh extension.

3. Results and discussion

No effect of position was observed on the difference of maximal anterior pelvic tilt before and after the 30 min effort on a bike ($F = 1.8$, $p = 0.190$). Similarly, the Delta of maximal thigh flexion and extension were not affected by the position on the bike (respectively, $F = 1.4$, $p = 0.256$; $F = 4.2$, $p = 0.053$). In sum, the lower-limb joint kinematics (hip, knee, and ankle) were similar between the two positions, in terms of range of motion.

In their study, Rendos et al. (2013) observed a modification of lower extremity kinematics following a 30-min cycling effort in aerodynamic position. They observed a greater maximal anterior pelvic tilt and thigh extension. Rendos et al. (2013) suggested that the prolonged trunk flexion on the bike could induce a viscoelastic creep response of the paraspinal muscle, affecting spine and lower-limb kinematics.

The fact that we did not observe a significant effect of position on pelvic and hip kinematics may suggest that the potential creep response following flexed posture is not the only factor affecting the run session in triathlon. Instead, a modification of lower-limb stiffness following cycling (Sayers, 2012) may also contribute to the change of kinematics, in both positions. Indeed, we showed previously that a modification of stride length due to a modification of frequency (and thus of lower-limb stiffness) has a greater impact on hip and pelvic kinematics than a similar change following an increase of running speed (Dewolf & De Jaeger, 2015). Also, the reports of incoordination at the beginning of the run may be related to changes in inter-segmental coordination. As shown through in-depth analysis (Walsh et al., 2023), future studies on coordination may reveal modified coordination between the thigh and pelvic segments after cycling, depending the position on the bike.

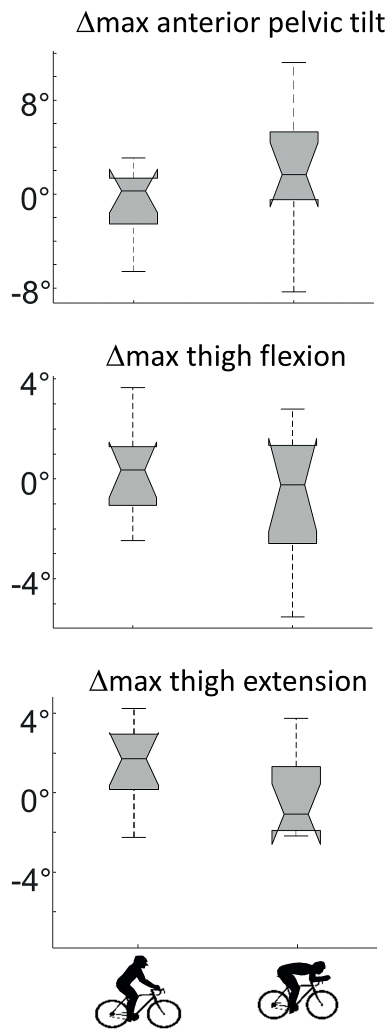

Figure 1. Box plot of the $\Delta_{post\text{-}pre}$ of max pelvic tilt, thigh flexion and thigh extension as a function of cycling position. Within each box, horizontal white lines denote median values; boxes extend from the 25th to the 75th percentile of each group's distribution of values.

4. Conclusions

Contrary to expectations, we did not find a significant effect of cycling position on maximal anterior pelvic tilt, thigh flexion, or thigh extension. This suggests that factors beyond trunk flexion-induced viscoelastic creep, such as lower-limb stiffness modulation, may contribute significantly to post-cycling kinematic alterations.

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