BOOK OF ABSTRACTS **Open Access**

Differences in Strength & Power profiles between Road and Time Trial cyclists

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Introduction:

Within the scientific literature there is little evidence available to provide practitioners with information on strength and power profiles of cyclists, resulting in a limited understanding of neuromuscular factors related to cycling performance. Information on the legs' elastic energy utilisation, force-velocity and length-tension curves can inform training programs and aid in talent identification. Other sports where such information is more widely available have already successfully implemented this within preparation programmes (e.g. McBride et al., 1999).

Methods:

A total of 44 cyclists were recruited for this project, of which 15 classified in a Novice category by having no racing experience at all (age 35.5 ± 11.4 yrs; height 177.4 ± 6.5 cm; mass 77.4 ± 9.3 kg; FTP 3.28 ± 0.47 W/kg), 14 in the Road racing category as they competed for at least the past year at British Cycling Category 2 level or higher and no experience in Time-Trial (TT) races (age 35.9 ± 12.7 yrs; height 179.1 ± 6.5 cm; mass 76.6 ± 9.0 kg; FTP 3.88 ± 0.49 W/kg), and 15 in the TT category as they considered TT racing as their main competitive aim, rode in dedicated TT positions and had recently produced a 10 or 25 mile personal best of <23 or <58 minutes respectively (age 38.0 ± 9.6 yrs; height 184.0 ± 3.9 cm; mass 80.1 ±6.2 kg; FTP 3.74 ± 0.46 W/kg).

Muscle function was tested through a range of tests. Jump height achieved during a squat jump (SJ) and a countermovement jump (CMJ) was used to define the balance between muscular power and elastic capacities of the legs (Kubo et al., 2000). A 20-Kg loaded jump squat (LJS) was used alongside the CMJ to provide data on the force-velocity relationship (F-V) in a multi-joint movement by calculating the theoretical peak force (F_{peak}), theoretical peak velocity (V_{peak}) and theoretical peak power (P_{peak}) values (Cuk et al., 2014). Force plates (Kistler, Switzerland) recorded data during the jumps at 2000Hz.

Furthermore, single joint isokinetic dynamometry (Biodex, USA) of the hip and knee was conducted for a range of angular velocities (30 to 270 °/s) to capture an accurate strength profile of the relevant muscle groups. Torque-Velocity profile was quantified by determining the relative reduction in torque with increasing velocity, length-tension relationships were evaluated using the angle of peak torque at 30 °/s and relative strength was quantified as a hip/knee torque ratio.

Results:

The cyclists tested showed an average jump height of 29 ± 6 cm, 25 ± 5 cm and 20 ± 5 cm for the CMJ, SJ and LJS respectively, there were no significant differences between the groups (p = 0.939). The ratio of SJ over CMJ height averaged on 0.87 ± 0.11 with competitive cyclists scoring slightly but not significantly lower (0.84 ± 0.09) than the novice cyclists (0.89 ± 0.12; p = 0.329). Calculating F_{peak}, V_{peak} and P_{peak} from the two-load method (CMJ and LJS), produced averages of 1903 ± 472 N, 5.74 ± 4.38 m/s and 2620 ± 1581 W respectively with no significant differences between the groups (p = 0.666, p = 0.520 & p = 0.396 respectively).

Dynamometry data revealed a greater hip joint torque over knee torque in flexion and extension (hip/knee ratio > 1) for all groups. This dominance was significantly less prominent in the TT group for flexion conditions (1.35 ± 0.18) compared to Road (1.56 ± 0.22; p = 0.031) and Novice (1.53 ± 0.19; p = 0.004) groups. Joint flexion torques showed non-significant trends; they were slightly higher in the knee and lower for the hip (1.43 & 2.08 Nm/kg respectively) in TT athletes compared to Road (1.35 & 2.14 Nm/kg) and Novices (1.36 & 2.22 Nm/kg) (p = 0.429 & 0.189). No differences were found for the angle at which peak torque occurred. The velocity effect on torque production was comparable between the groups. It decreased from its peak at 30 °/s, to 82 ± 11 % of that when tested at 270 °/s for knee flexion and to 61 ± 9 % for knee extension. Hip torque reduced to 66 ± 10 % and 79 ± 10 % for flexion and extension respectively, when tested at 210 °/s compared to 30 °/s condition.

Discussion

The CMJ data show that cyclists – both novice and competitive – perform poorly on vertical jumping (29 ± 6 cm) compared to strength trained (48.2 ± 2.8 cm) and even untrained individuals (33.7 ± 2.3 cm) (McBride et al., 1999). This is in line with previous research on endurance type athletes showing long-distance runners to perform inferiorly on jump tasks compared to an untrained population (27.8 ± 4.3 cm vs 37.3 ± 3.1 cm; Kubo et al., 2000). In contrast to the findings by Kubo et al. (2000), the tested competitive cyclists showed lower SJ/CMJ ratios compared to the untrained controls indicating a relatively large utilisation of elastic energy storage compared to muscular power in jump performance.

Based on the dynamometry testing, it seems most plausible to suggest that the reduced hip flexion capacity in TT riders results from these muscles being disused during cycling due to the extreme hip flexion angles common in their riding positions. It could be suggested that an attempt is made to compensate for this loss in hip flexion capacity through increased knee flexors' strength. An increased knee flexor torque in TT riders could also indicate a mechanically more effective pedalling technique on the bike, as previous literature has linked hamstring activity with increases in Index of Force Effectiveness on the bike (Bini et al., 2013). Greater separation between tested groups might have been masked due to variation in preferred bike setup within the groups, TT riders also training in road setups and novice cyclists having undergone minor adaptations through recreational cycling activities.

Based on these results, it seems appropriate to advise strength training to be tailored to the type of competition a cyclist is aiming to perform on. TT riders should focus on knee flexor strength, while road cyclists could benefit from a more balanced approach between hip and knee strength. Currently ongoing research is investigating how these strength characteristics relate to determinants of cycling performance in order to further help optimising training protocols and talent identification strategies.

References:

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