their best efforts. They wore their usual practice swimsuits with reflective markers. The swimming movements were measured with a 3 dimensional motion capture system at 50M intervals.Blood lactate was also measured before and after the task of 200M swimming to monitor their fatigue levels. It was shown that their swimming speed decreased clearly with the swimming distance and the blood lactate levels also increased after the task. Biomechanical analysis indicated that rotation of trunk and pelvis increased while the position of the pelvis went down and kept low, seemingly causing the drag force in water higher.

Poster-70

Is leg kicking workout position affecting kinematic and hydrodynamic variables in front crawl?

André BRITO (Research Center in Sports Sciences, Health Sciences & Human Development, CIDESD, Vila Real, Portugal, Portugal), Jorge MORAIS, Tiago BARBOSA, António SILVA, Diogo OLIVEIRA, Victor REIS, Nuno GARRIDO

Swimming training includes leg kicking workouts, whereas swimmers choose between head out (HO) or head in (HI) position holding a flutter kick board. Our objective was to characterize and analyse differences between the two leg kicking positions in Swimming Velocity (V, in m/s), Intra-cyclic variation of the horizontal velocity (dv, dimensionless), Active Drag (D, in N), Hydrodynamic Coefficient (CD, dimensionless), Mechanical Power (P, in W) and frontal surface area (FSA, in m2). Thirteen swimmers (15.3 ± 2.9 years-old) participated in this study. Frontal surface area was calculated according to the proposal of Morais et al. (2011) by photogrammetry. After a standard warmup, swimmers performed 4x25m bouts at maximum velocity as follows: i) 2Xcrawl HO leg-kick; ii) 2Xcrawl HI leg-kick. In the first bout of each the V and the dv were measured using a speed-meter cable that was attached to the swimmer's hip (Barbosa et al., 2013). In the second bout CD was obtained through the velocity perturbation method (Kolmogorov and Duplishcheva, 1992). The swimmers were videotaped during the bouts in the sagittal plane and trunk inclination angles were calculated with video software Kinovea. Throughout these angles (relative to surface mean±SD, HO=16.8±1.9o; HI=18±2.9o, p=.241) an AutoCAD (V19.2) reconstruction of the swimmer frontal plane photo was done. The HO and HI FSA were then calculated. D was obtained through Newton's equation D=1/2p*FSA*CD*V^2 and P=DxV. Independent Sample t-test was used to analyse differences between two conditions. Effect size was calculated with Cohens' d. No-significant differences were found in any variable assessed in our study, however some results should be highlighted (Results presented in mean±95%IC). The V and FSA in HO were higher than in HI condition (1.01±0.08m/s vs 0.98±0.11m/s, p=.61; 0.12±0.02m2 vs 0.11±0.01m2, p=.46, respectively). In HO the dv, D, CD and P were lower than in HI condition (7.40±1.42 vs 8.18±2.53, p=.48; 33.32±14.74N vs 37.57±13.78N, p=.65; 0.52±0.19 vs 0.65±0.21; p=.33; 36.03±17.82W vs 38.74±16.41W, p=.81, respectively). Under the observed data, there is no difference between the two workout positions. Swimmers can be advised to freely choose the leg-kick position in their training. However, HO condition permitted higher V and lower D.

Poster-71

Relationships between upper limb motion and flow fields around the limb in front crawl

Rina EBIHARA (University of Tsukuba, Japan), Hirofumi SHIMOJO, Tomohiro GONJO, Yasuo SENGOKU, Hideki TAKAGI

Swimmers primarily produce propulsive forces by the upper limbs in front crawl. A change in propulsive forces is caused by a change in the pressure distribution around the hand, and the pressure distribution depends on the water flow that is affected by the motion of the swimmer. Therefore, we need to examine the motion, hydrodynamic forces, and flow fields around the upper limb during front crawl arm stroke. The relationship between pressure distribution around the hand and upper limb motion has been investigated. However, flow field around the hand during the front crawl arm stroke, which produces the pressure distribution changes, have never been observed using a real human. Therefore, the aim of this study was to observe the upper limb motion and flow fields around the upper limb during front crawl by motion analysis and 3D flow visualisation using a real swimmer. The testing was conducted in a swimming flume with the flow velocity of 1.2 m·s−1. The participant was a male university swimmer, and a 3D motion capture system and particle image velocimetry (PIV) method were used for the data collection. In PIV, the range of the observable area was limited, and thus, the swimmer swam at 24 different positions in the flume to obtain data in different stroke phases. We observed a counter-rotating pair-vortex on the dorsal side of the hand and wrist around the end of the out-sweep and the beginning of the in-sweep. Furthermore, we also observed a flow being induced between the vortices. These phenomena indicate that the turbulent on the dorsal side of the wrist and hand is stronger than that on the palmar side, which might cause a difference in pressure distribution between the sides, which produces propulsive forces by the hand. In conclusion, front crawl stroke can be characterised by two counter-rotating vortices and flows on the dorsal side of the hand and wrist.

Poster-72

Lower limb 3D kinematics of elite swimmers during the push-