Biomechanics of the kick-start motion in competitive swimming

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Researchers from the Faculty of Health and Sport Sciences at the University of Tsukuba have analyzed the "kick-start" technique used by swimmers when beginning a race. On the basis of force and velocity measurements, the team showed that both the vertical and horizontal forces exerted by the athletes' hands on the front of the starting platform helped the swimmers achieve proper form. This work may help

swimmers increase their overall performance in races.

As people watching the recent Summer Olympics are well aware, the time interval separating a Gold medalist from a non-medalist can be a fraction of a second. In fact, the race can be won or lost at the starting signal—before any swimming happens at all—when each athlete pushes off the platform to get the fastest velocity, along with the shortest possible reaction time, when entering the pool. However, the biomechanics of the "kick-start" technique have not been studied nearly as much as the rest of the race. One complication is that all four of the swimmer's limbs are involved, because they can grasp the front edge of the starting platform with both hands while simultaneously pushing off with their feet.

Now, to address this issue, a research team led by the University of Tsukuba has conducted experiments with eight male collegiate swimmers who qualified for the Japan National Championships. The team used separate force sensors for the front foot and back foot, and triaxial force sensors for each of the hands. In addition, forty-five reflective markers were attached to each swimmer's body with a motion-capture system.

The researchers found that, in contrast with a track sprinter in the starting blocks who cannot exert significant horizontal force with their hands against the ground, swimmers use their hands to hold their bodies on the blocks and then push forward when executing a kick-start.

"To understand optimal body movement on the starting platform for maximizing take-off velocity, it is necessary to investigate the joint torque in relation to its effects on athlete performance," senior author Professor Hideki Takagi says.

In addition, because drag in air is much lower than in water, swimmers

should try to be moving in the forward direction as fast as possible at the instant of take-off from the starting platform. This requires pushing on the platform so that the resulting force propels them both forward as well as upward so as to counteract the effects of gravity. "The kick-start technique in competitive swimming generates a force acting on the starting platform owing to gravity, muscle contraction, and resulting joint torque," Professor Takagi explains.

Overall, both swimmers and coaches can benefit from improved understanding of how the force exerted by the hands, which is primarily generated by shoulder joint extension torque during a kick-start, actually acts more vertically than horizontally.

More information: Shin Sakai et al, Kinetics of four limb joints during kick-start motion in competitive swimming, *Sports Biomechanics* (2021). DOI: 10.1080/14763141.2021.1963465

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