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Review article

Biomechanical Analysis of the Swim-Start: A Review

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ABSTRACT

This review updates the swim-start state of the art from a biomechanical standpoint. We review the contribution of the swim-start to overall swimming performance, the effects of various swim-start strategies, and skill effects across the range of swim-start strategies identified in the literature. The main objective is to determine the techniques to focus on in swimming training in the contemporary context of the sport. The phases leading to key temporal events of the swim-start, like water entry, require adaptations to the swimmer's chosen technique over the course of a performance; we thus define the swim-start as the moment when preparation for take-off begins to the moment when the swimming pattern begins. A secondary objective is to determine the role of adaptive variability as it emerges during the swim-start. Variability is contextualized as having a functional role and operating across multiple levels of analysis: inter-subject (expert versus non-expert), inter-trial or intra-subject (through repetitions of the same movement), and inter-preference (preferred versus non-preferred technique). Regarding skill effects, we assume that swim-start expertise is distinct from swim stroke expertise. Highly skilled swim-starts are distinguished in terms of several factors: reaction time from the start signal to the impulse on the block, including the control and regulation of foot force and foot orientation during take-off; appropriate amount of glide time before leg kicking commences; effective transition from leg kicking to break-out of full swimming with arm stroking; overall maximal leg and arm propulsion and minimal water resistance; and

minimized energy expenditure through streamlined body position. Swimmers who are less expert at the swim-start spend more time in this phase and would benefit from training designed to reduce: (i) the time between reaction to the start signal and impulse on the block, and (ii) the time in transition (i.e., between gliding and leg kicking, and between leg-kicking and full swimming).

Key words: Biomechanics, expertise, performance, techniques, variability

Key Points

- Swimmers meet two main constraints during the start movement: travelling more distance in the air (to get less resistance) and rotate to enter properly in the water.
- Swim start is a sum of compromises in all parts of it, and swim-start expertise is distinct from swim stroke expertise corresponding to best ways to manage these compromises.
- Variability found is contextualized as having a functional role and operating across multiple levels of analysis.

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