Pacing Strategies in Men's Freestyle Swimming: A Model-Based Approach at the World Elite Level

Summary

This doctoral dissertation examines pacing strategies in men's freestyle swimming, approached from a model-based perspective at the world-class elite level. The aim of the study was to develop model pacing patterns for the 100, 200, 400, 800, and 1500 m freestyle events held in a long-course pool (50 m). The rationale for undertaking this topic stemmed from the lack of comprehensive studies on actual pacing patterns in competitive swimming that would cover the full range of race distances and be based on material derived from the finals of the most important international competitions. Previous research has usually focused on individual races, selected athletes, or specific distance groups, which has limited the possibility of identifying dominant and repeatable pacing patterns. At the same time, swimming, due to the high degree of standardization of competition conditions, constitutes a particularly useful model for the analysis of pacing strategies.

The research material comprised results from the finals of the most important swimming competitions of the 21st century: the Olympic Games (6 editions; Sydney 2000–Tokyo 2020), the World Championships (13 editions; Fukuoka 2001–Doha 2024), the European Championships (11 editions; Berlin 2002–Rome 2022), the Commonwealth Games (5 editions; Melbourne 2006–Birmingham 2022), and the Pan Pacific Championships (4 editions; Victoria 2006–Tokyo 2018). The analysis included 312 results in the 100 m event, 311 results in the 200 m event, 303 results in the 400 m event, 199 results in the 800 m event, and 303 results in the 1500 m event, corresponding to 624, 1244, 2424, 3184, and 9090 split times, respectively. The collected material was subjected to statistical analysis using repeated-measures analysis of variance, post hoc comparisons with Bonferroni correction, and general linear models. In all analyses, the level of statistical significance was set at $\alpha = 0.05$.

The results confirmed the adopted research hypotheses and demonstrated that world-class athletes display similar pacing strategies, which makes it possible to distinguish relatively unified models of speed variation across successive phases of the race. It was found that

the greatest dynamics of pace changes occur primarily in the initial and final parts of the race, whereas the middle section is characterized by relatively greater speed stability. This pattern was particularly evident when sprint and long-distance events were compared: in sprint races, pace changes were more abrupt, whereas in longer races, greater importance was attached to maintaining a relatively even pace in the middle phase of the race and to the appropriate execution of the finishing section. Furthermore, it was demonstrated that a positive split strategy predominates in short-distance events, manifested by a relatively faster completion of the initial part of the race, whereas in longer races the pacing pattern more often assumes a parabolic form, with a more controlled start, a more stable middle section, and a more pronounced acceleration in the final phase of the race. As race distance increases, the pacing pattern becomes increasingly curvilinear, indicating greater complexity of pacing strategies in long-distance events.

The original contribution of the dissertation lies in the identification and model-based description of dominant pacing patterns in men's freestyle swimming over distances ranging from 100 to 1500 m, based on extensive empirical material covering the finals of the most important swimming competitions of the 21st century. The obtained findings expand current knowledge of the mechanisms underlying sporting success in competitive swimming and may provide a basis for improving race strategy, monitoring race execution, and optimizing the training process.