

Biomechanics and energetics as determinant factors of competitive swimming performance: exploratory approaches to link selected variables

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INTRODUCTION Research in competitive swimming has given special emphasis to energetics and biomechanical assessments. The main concern of this paper was to summarize evidence about exploratory approaches to link selected biomechanical and energetics variables to performance in adult/elite swimmers.

MATERIALS AND METHODS Electronic searches were made on PubMed, ISI Web of Knowledge, Index Medicus, MEDLINE, Science Citation Index, Scopus, SPORTDiscus, and hand searches of conference proceedings and departmental files. Our search strategy identified several papers, which were then assigned to one of the two main categories (biomechanics-energetics relationships; energetics/biomechanics-performance relationships) according to their reported data. Included studies focused on researches about the relationships between energetics, biomechanics and performance with adult/elite swimmers. Excluded were: (i) studies not assessing the biomechanics-energetics relationships and/or the energetics/biomechanics-performance relationships; (ii) studies based on other scientific domains; (iii) studies using other competitive levels as subjects (e.g. age-group or masters) instead of elite swimmers and; (iv) not being made exploratory researches (e.g., revision papers, confirmatory modeling). In respect to the research question, relevant studies were categorized in two main groups: (i) biomechanics-energetics relationships; (ii) energetics/biomechanics-performance relationships.

RESULTS Our search identified 363 potential relevant papers of which 265 did not meet the inclusion criteria. A total of 98 studies were considered for further analysis. The reasons for exclusion were being focused: (i) on other swimming techniques, e.g., starts and turns (42 studies); (ii) on other scientific topics or isolated assessment of performance, biomechanics or energetics variables (152 studies); (iii) participants from other competitive levels (34 studies) and; (iv) are not exploratory data analysis researches (37 studies).

CONCLUSIONS The main findings were that high-level swimmers are more economical. To increase swimming economy, swimmers should decrease the speed fluctuation and increase the stroke length at given velocity. Plus, to decrease the speed fluctuation and achieve higher velocities, they also must have high segmental velocities in the most propulsive phases of the stroke cycle and lower drag force in the less propulsive ones. As a conclusion, the energetics and the biomechanical knowledge, once isolated, are not enough for swimming enhancement. Performance is dependent from energetics and this one from biomechanics.