

## Kinematic Comparison of Underwater Dolphin and Flutter Kicking Performed in a Prone and Supine Body Position

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### ABSTRACT

Despite an increasing emphasis on underwater dolphin kicking in competitive swimming, little objective research exists to explain its preference over flutter kicking. **PURPOSE:** To examine kinematic characteristics of flutter and dolphin kicking performed in prone and supine body positions. **METHODS:** Ten collegiate swimmers ( $1.77 \pm 0.07$  m,  $72.4 \pm 7.6$  kg,  $19.8 \pm 1.0$  yrs) experienced with dolphin and flutter kicking completed eight 10 m maximal effort underwater kicking trials. Body position and kicking style were randomly varied between trials such that half of all trials were performed using each kicking style and each body position. A calibrated underwater camera was used to record each trial at 60 Hz. Six body landmarks were digitized for three complete kicking cycles to determine linear and angular kinematic measurements. Whole body speed was defined as horizontal hip velocity. Kicking amplitude and frequency were determined using vertical toe movements. The Strouhal number, a dimensionless index related to the efficiency of underwater undulatory movement, was computed using the kicking amplitude, frequency and velocity. Kinematic measures were compared between kicking style and body positions using a 2x2 (kick x position) repeated measures ANOVA. **RESULTS:** Dolphin kicking velocity ( $1.22 \pm 0.18$  m/s) was faster ( $p < 0.001$ ,  $\eta^2 = 0.88$ ) than flutter kicking velocity ( $0.99 \pm 0.12$  m/s). Dolphin kicking amplitude ( $0.58 \pm 0.10$  m) was larger ( $p < 0.001$ ,  $\eta^2 = 0.93$ ) than flutter kicking amplitude ( $0.48 \pm 0.08$  m). Dolphin kicking frequency ( $1.85 \pm 0.34$  Hz) was lower ( $p = 0.002$ ,  $\eta^2 = 0.68$ ) than flutter kicking frequency ( $2.33 \pm 0.33$  Hz). Dolphin kicking ( $0.88 \pm 0.12$ ) was more efficient as indicated by a lower Strouhal number ( $p = 0.001$ ,  $\eta^2 = 0.71$ ) than flutter kicking ( $1.11 \pm 0.21$ ). Body position had no effect on any measure of kicking performance ( $p > 0.05$ ). **CONCLUSION:** For these participants, dolphin kicking was a faster, more efficient form of underwater kicking. However, body position had little effect on the ability of these participants to perform the respective kicking style.