A Comparison of Stroke Length During Surfboard Paddling on a Modified Swim Ergometer vs. Swim Flume in Recreational Surfers

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ABSTRACT

Surfers spend a majority of their time in the water paddling while lying prone on a board, yet little is known regarding the biomechanical properties of this motion. Researchers have used a modified swim ergometer to study this motion in the laboratory, but recent evidence suggests that this device may not be a good surrogate for the study of paddling in water. PURPOSE: The purpose of this study was to compare self-selected stroke lengths obtained while paddling on an ergometer with those obtained while paddling in a swim flume at a comparable workload. METHODS: Nineteen recreational surfers, with mean age (27.26 ± 10.42 years), height (1.76 ± 0.06 m) and weight (68.42 ± 12.52 kg) volunteered to participate. Subjects performed two, one-minute paddling sessions at predetermined speeds of 2:20 and 1:50 (min:sec/100 meters) on both the modified swim ergometer and in the swim flume. The subjects were recorded using GoPro Hero4 cameras, and stroke lengths were determined offline through manual digitization of two-dimensional video. RESULTS: Stroke lengths in the flume were significantly longer than stroke lengths on the ergometer during both the slow speed (1.270 ± 0.081 m vs 0.957 ± 0.112 m , $p<0.001$) and fast speed (1.272 ± 0.106 m vs 1.029 ± 0.099 m, $p<0.001$) conditions. Overall, stroke lengths were consistently longer in the swim flume for all subjects regardless of age, gender, surf experience, or preferred board type. DISCUSSION: These data provide additional support for the idea that a modified swim ergometer is biomechanically different from paddling in water. Future biomechanical investigation of the paddling motion should occur in a water medium.

BACKGROUND

- **Surfing is increasing in popularity.** There are approximately 10-20 million people participating in surfing worldwide more more than 2.1 million surfers in the United States alone.[1]
- **Surfers spend the majority of their time in the water paddling.** Competitive surfers spend approximately 51% of their time paddling, 42% sitting, and only 5% of their time riding waves. Recreational surfers spend less time paddling, but are still at risk for overuse injuries related to paddling.[2-3]
- **Studying the biomechanical properties of surfboard paddling may help to improve performance and reduce risk for injury.[4-5]** Unfortunately, it is difficult to acquire useful while athletes are in the water.
- **Many researchers have used a modified swim-bench ergometer to study paddling in the laboratory.[6-8]** However, it remains unclear how well this device replicates the surfboard paddling motion while in water.

The purpose of this study was to compare self-selected stroke lengths obtained while paddling on an ergometer with those obtained while paddling in a swim flume at a comparable workload.

METHODS

Subjects

19 recreational surfers performed a series of paddling tests. Surfers were at least 18 years of age and had at least 1 year of surfing experience

Age [yrs]	Height [m]	Mass [kg]
27.26±10.42	1.76±0.06	68.42±12.52

METHODS

Equipment

- GoPro Hero 4 cameras were used to record the paddling motion on the ergometer (Fig 1) and in the swim flume (Fig 2).
- Fisheye effect was removed using GoPro Studio software.
- MaxTraq motion analysis software was then used to digitize the video and quantify paddling strokes.

Figure 1 *Vasa Inc.* swim bench ergometer (left), experimental setup (right). Subjects did not wear a wetsuit in either paddling condition.

Figure 2 Sample image captured with GoPro Hero 4 camera placed underwater in the swim flume. Video was captured at 60 Hz and 720p resolution.

Procedures

- Each subject performed a total of 4 paddling trials in random order. All trials were 60 sec in length.
- Two trials were performed in the swim flume at a speed of 2:20 (min:sec/100 meters or 0.71m/s) and at a speed of 1:50 (min:sec/100 meters or 0.91 m/s). Subjects paddled the same board for all trials.
- Two trials were performed on the ergometer at a comparable workload.
- Paddling cadence was not controlled; subjects were allowed to self select their preferred cadence and stroke in each condition.
- GoPro cameras were placed perpendicular to the sagittal plane of the prone subject; on a tripod for ergometer trials and using a suction mount for the flume trials.
- Cameras acquired data at 60 Hz and 720p resolution.
- A 1 meter linear scale was used for both conditions.
- Stroke trajectories were manually digitized using MaxTraq software.
- Paired t-tests were used to compare differences in hand displacement under each condition and paddling speed.

RESULTS

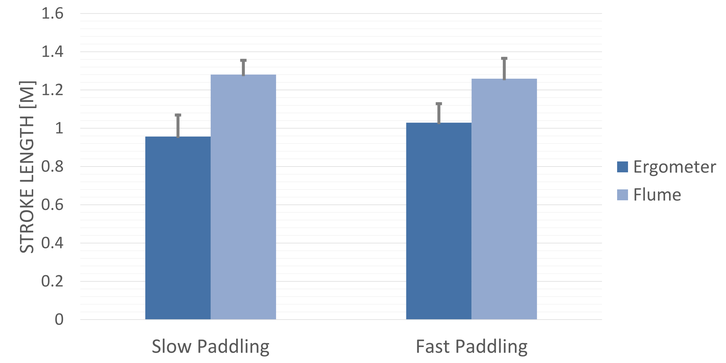

Figure 3 Mean stoke length for each condition at 2 different velocities (0.71 m/s and 0.91 m/s). Stroke length in the flume was significantly greater than that recorded on the ergometer at both paddling velocities ($p<0.001$).

These results suggest that there are significant differences in the biomechanical properties of the paddling motion when performed on a swim bench ergometer vs. water medium.

CONCLUSIONS

- There is a significant difference in stroke length between paddling on a modified swim ergometer and in a swim flume in recreational surfers with at least one year of surfing experience.
- The swim flume may provide a more accurate representation of the natural paddling motion and is therefore preferred for future biomechanical analyses of surfboard paddling.

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