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Aerobic capacity and propulsive forces during freestyle swimming using the Bowswim®

Introduction: Many triathlon swimming events and marathon swimming events are performed in open water environments that require a persistent freestyle swim technique without pool style flip turns. To maximize the specificity of training for these events, training would take place in an open water environment. However, accessibility to open water environments can be logistically challenging and using expensive swim flumes that mimic persistent swimming may be not feasible. Tethered swimming using a flexible restraining device is an additional technique that enables the swimmer to focus on persistent swimming at any volitional speed or intensity without the need for flip turns. Additionally. tethered swimming devices are relativity inexpensive and can be performed in small pools. What is unclear is if a commercially available tethered apparatus (i.e., Bowswim) provides comparable aerobic capacity and propulsive force values to flume and free swimming.

Purpose: The purpose of this study was to quantify the aerobic capacity (i.e., maximal volume of oxygen consumed, $V0_{2max}$) and force contribution during freestyle swimming using the tethered Bowswim apparatus.

Methods: A total of 12 trained swimmers participated in the study (mean age = 24.3 ± 3.85 yrs). Most participants were pool lifeguards who swam about 3 days/week for the purpose of sport and recreation. Prior to participating in the study, all participants read and signed an informed consent form approved by the Utah State University Institutional Review Board (IRB). Participants attended two test sessions separated by a minimum of 24 hrs. All testing occurred in a HydroWorx 2000 therapy pool. The first visit to the pool was used to familiarize participants with the testing procedures and equipment. They were also given an opportunity to swim for a self-selected time period using the Bowswim. This familiarization session was important to minimize any learning effects that might occur using the Bowswim. The second visit required participants to perform a standardized graded exercise test to voluntary exhaustion. For this test, a resistive strain gauge was mounted in series with the Bowswim tether to measure the force of pull exhibited by the swimmer. The protocol for the graded exercise test began by having participants swim freestyle with a force of 20 N. Participants were then asked to increase the force by 10 N every 3 min until voluntary exhaustion. The $V0_2$ was recorded during the entire graded exercise test using a computerized on-line metabolic measurement system. Calculations of $V0_2$ (l•min-1 STPD) were made from expired air samples taken from participants breathing through a two-way valve mouthpiece (Hans Rudolph 700 series, Kansas City MO). The centrality and spread were computed for collected outcome measures ($V0_2$ and force) using SPSS software.

Results: The mean absolute $V0_{2max}$ value for all participants was 3.4 ± 0.27 L/min. This value is consistent with data reported in the literature for free swimming in a lap pool (e.g., ≈ 3.5 L/min; Roels et al. 2005) and higher compared to swimming in a flume (e.g., ≈ 2.6 L/min; Bonen et al. 1980). Maximal force collected during the graded exercise test was about 70.4 ± 7.3 N with a minimal value of 28 ± 7.3 N. The maximal value approximates forces produced by competitive swimmers performing a maximal 30 second freestyle sprint while tethered (Morouco et al., 2014).

Conclusions: Recreational swimmers using the tethered Bowswim apparatus displayed $V0_{2max}$ values that were similar or greater than values reported in the literature for open and flume swimming suggesting the Bowswim is an effective device for training the cardio-respiratory system in swimmers. Further, the large range of forces observed during the graded exercise test suggests the Bowswim provides the capacity for a wide range of training intensities, which are critical for achieving performance improvements in competitive swimmers.

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