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Poster 2

STRENGTH A STRONG PREDICTOR OF PADDLING PERFORMANCE IN COMPETITIVE SURFERS

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INTRODUCTION

Competitive surfing involves grouping 2-4 surfers in each competitive heat, which generally lasts 20-30 minutes, dependent on the format of the competition, and the surf conditions. Competitive success is determined by a judging criterion that evaluates the athlete's ability to ride the best waves, performing radical manoeuvres under control. In other words, surfers' success is judged by their ability to obtain and ride the waves with the best scoring potential, and ride them better than their opposition. Like any tournament style competition, the successful surfers from each round of competitive heats progress through the competition until quarter, semi, and final rounds are completed, and placing is determined.

Surfing (wave-riding) competition takes places in a variety of conditions that have a large effect on activity patterns such as duration of wave-riding and time spent paddling (5, 7, 8). The type of wave-break, and changing conditions such as wind, swell, and tide conditions greatly influence the nature of the surfing activity. However, both competitive and recreational surfing suggest that surfing can be characterized as a sport requiring multiple short duration intermittent paddle efforts (5, 7). In a competition, wave riding duration was found to be only 3.8% of total time, with paddling accounting for 51.4% of time, and no activity (i.e. stationary sitting on board) representing 42.5% of total time (miscellaneous activities 2.2%)(7). Although the mean paddling bout in a surfing competition was found to be ~30 seconds, the majority (~60%) of these paddling bouts were only 1-20 seconds (~25% <10 seconds, ~35% 10-20 seconds), highlighting the importance of shorter bouts of intense paddling (6, 7).

Previous examinations have determined that neither oxygen uptake nor endurance paddling measures are valid in discriminating between competitive and recreational surfers, but that short-duration paddling power may be a valid discriminator (3). Sprint paddling (in order to catch waves and to gain an advantage over their competitors in the heat) appears to be a key feature of competition in order to gain a position advantage for wave selection, but also to ensure fast entry speed into waves to optimize position on the wave face for the execution of manoeuvres that will maximize the judges' score (3, 6, 9). As such, sprint paddling ability is considered to be a significant factor in determining the competitive outcome.

Despite this, no studies have examined the potential relationship between trainable physical factors such as strength, with sprint paddling performance. Considering the role of upper-body power in swimming (2), it stands to reason that strength of the upper-body and trunk could play a key role in enhancing sprint paddle performance. This information would be useful in guiding coaching decisions and in providing a basis of rationale for strength-training in surfers. The present study aimed to evaluate the association with upper-body pulling strength with sprint kinematics of competitive surfers.

METHODS

To assess the association between strength qualities with sprint paddle performance, this study employed a correlation analysis within a group of adult male competitive surfers, as well as a comparison of strength qualities when athletes were grouped based on their sprint paddling velocity (faster and slower).

Ten competitive male surfers (23.9±6.8 years, 177.0±6.5 cm, 72.2±2.4 kg) participated in this study. At the time of the study, the subjects had competed, as a minimum standard, in domestic 'open' competition, with the majority of subjects having competed at International Surfing Association World Junior Championships, or the Association of Surfing Professionals World Qualifying Series events.

All subjects received a clear explanation of the study, including the risks and benefits of participation and if following this explanation their decision was to not be included in the analysis it did not adversely affect any current or future competitive or team opportunities. All included subject's provided written informed consent for testing and data analysis. Approval for this investigation was granted from the Institutional Human Ethics Committee, and the study conformed to the Declaration of Helsinki for medical research involving human subjects.

The subject group was divided into 2 equal groups. One group performed their sprint-paddle testing, whilst the other group undertook the strength assessment. At the conclusion of this and following a 10 minute recovery, the groups were then alternated so that all testing could be completed for all subjects.

Sprint paddle testing was conducted in an outdoor 50 m swimming pool. This allowed for easy outline of distances for the subjects, control for the potential effect of tides and currents experienced in most local waterways, and provided for professional supervision by lifeguards and elimination of potential dangers from marine creatures. Subjects performed a progressive warm-up, consisting of 200 m of low-intensity paddling, followed by a specific sprint paddling warm-up of 4 x 15 m sprint paddling efforts at 60, 70, 80, and 90 % volitional effort on ~2 minute time intervals. After 3-4 minutes rest, the subjects then performed 2 maximal effort sprint-paddling time-trials (i.e. 2 x 15 m) to determine maximum sprint paddling performance. The sprint paddle efforts were initiated from a stationary, prone lying position, with the fastest time to 15 m of the 2 trials retained for analysis.

Using a purpose-built horizontal position transducer (I-REX, Southport, Australia) attached to the rear waist line of each subjects' board-shorts, kinematic data was obtained and stored for analysis on a personal computer. The position transducer recorded a time-stamp for each 0.02 m of displacement, thereby allowing for determination of sprint time from the start to each interval (5m, 10m, and 15m) and by differentiation to determine peak sprint paddle velocity (4). The %TE for 5m, 10m, 15m, and peak velocity were 4.4%, 2.6%, 2.1%, and 2.2% respectively,

Subjects were assessed on their 1 repetition maximum (1RM) for the Pronated Pull-Up. Prior to the strength testing, subjects performed 3 sets of a 30 second medicine ball circuit emphasizing upper-body and trunk activity, with 1 minute rest between each medicine ball set. Four to five sub-maximal preparatory sets (2-4 reps), separated by 2-3 minutes rest, were used to graduate the subjects' resistance load prior to the 1 RM trials. Subjects' were lifted to the final (i.e. upper) position with arms flexed fully at the elbow and the elbows in line with the scapulae such that the arms were flexed at the shoulder and scapulae adducted. The subjects then performed the initial eccentric action to a complete 'hang' position, then the concentric action to return to the start position. Additional load (in 2.5kg increments) was added by suspending certified plate weights from a standard lifting belt worn around the waist. Between 1RM trials 2-3 minutes rest was provided until a failed lift occurred, at this time the successful weight lifted in the previous lift was recorded as the subjects 1 RM. A composite ratio of 1RM Pronated Pull-Up/Subjects body-mass was used to determine Relative Pronated Pull-Up performance (to reflect the subjects' relative upper-body pulling strength).

Pearson correlation analysis was applied to determine the association between each of the primary variables. In addition the group was divided in half, based on the median of the time to 15 m, with strength characteristics assessed between these groups using independent t-tests, and cohen's effect size (*d*) applied to reflect the magnitude of any differences. For all tests, minimum significance was considered to be achieved when $p<0.05$.

RESULTS

Maximal pull-up strength was found to be moderately associated with time to 5 m (r=0.69), 10 m (r=0.61), and 15 m time (r=0.51), ($p<0.05$). Very strong associations were found between relative (total kg lifted/athlete mass) upper-body pulling strength and sprint paddling time to 5, 10, and 15 m (Figure 1, r= 0.94, 0.93, 0.88, respectively), and peak sprint paddling velocity (Figure 2, 0.66). Relative upper-body pulling strength was found to be superior ($p<0.05$) in the faster group, with large effect (d=1.88).

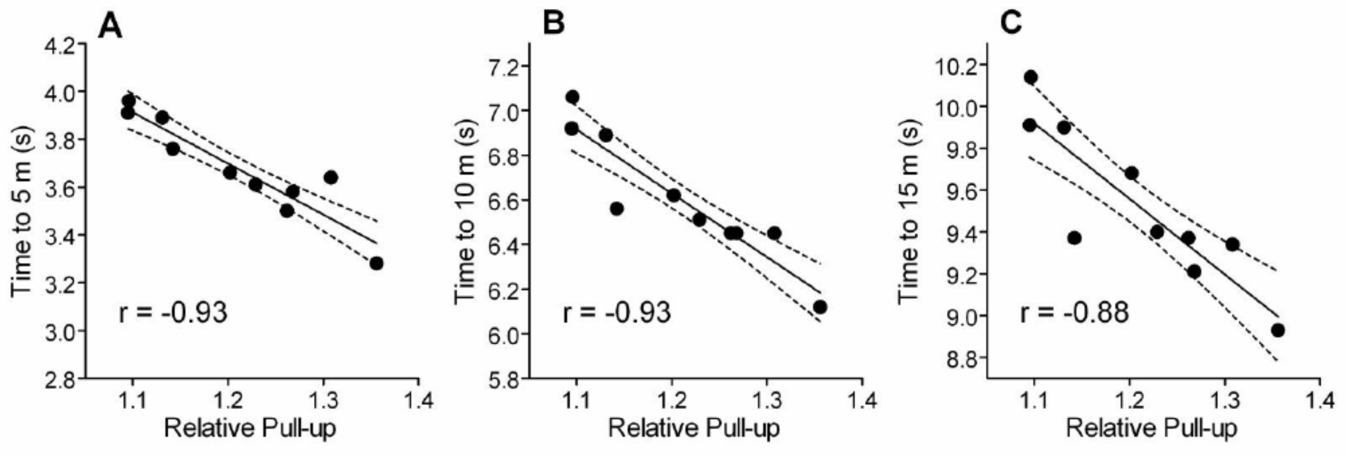

Figure 1 - The association between Relative Pronated Pull-Up Strength (1RM) and sprint paddling performance for 0-5m, 0-10m, and 0-15m in competitive surfers (n:10).

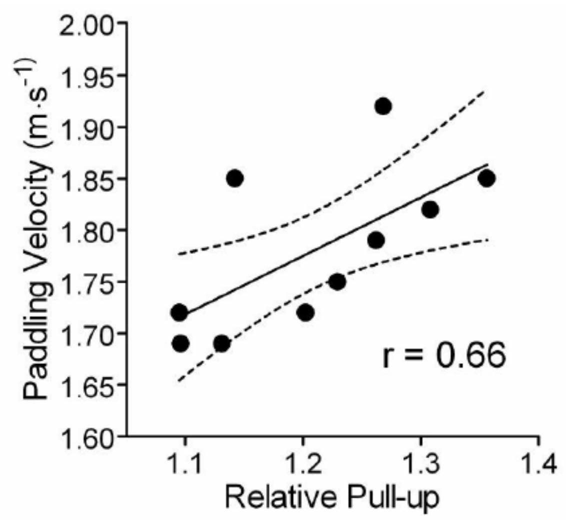

Figure 2 - The association between Relative Pronated Pull-Up Strength (1RM) and peak paddling velocity in competitive surfers (n:10).

Table 1 - A comparison of the Relative Pronated Pull-Up Strength between faster and slower sprint paddlers in a group of competitive surfers (n:10).

	Faster(n:5)	Slower(n:5)	P value	Effect Size
Relative Pronated Pull-Up Strength (1RM/Body-mass)	1.27	1.15	0.03	1.88

DISCUSSION

The purpose of this study was to evaluate the potential association between upper-body pulling (Pronated Pull-up) strength with sprint paddle kinematics of competitive surfers. This investigation seemed worthwhile, as although sprint paddling performance is believed to be important for surfers, strength-training in elite surfers is not highly adopted, nor is there an evidence base to support its use. The results of this study are novel, as they demonstrate a very strong association between relative upper-body pulling strength and sprint paddling performance in surfers.

Maximal pull-up strength relative to body-mass (total kg lifted/athlete mass) was found to have very strong associations with sprint paddling performance for both acceleration and top speed kinematics of sprint surfboard paddling (Figures 1 and 2). Furthermore, maximal pull-up strength relative to body-mass (maximum relative pull-up strength) was significantly (p=0.03) higher for the faster group, with a large magnitude of difference (*d*=1.88). This result suggests that surfers require highly developed upper-body pulling strength, but this must be accompanied by low-fat mass to optimize their relative upper-body strength score.

It stands to reason that the strongest association between relative pull-up strength is with time to 5 and 10 m (r=0.93), and the strength of this association declines as distance increases (15 m: r=0.88), and with peak sprint paddling velocity (r=0.66). As with any start to a movement (1), the surfer must overcome a higher resistance initially to accelerate themselves on the surfboard. As such it is logical that time from stationary to 5 and 10 m, distances that are dominated by acceleration towards top speed (4), are more highly associated with upper-body strength, and that with longer distances and at peak velocity, the influence of maximum strength would be slightly reduced.

This analysis has not demonstrated cause and effect between increased pull-up strength and improving sprint paddling ability. Further research efforts in this area should examine the chronic application of a strength training program and variations (e.g. closed vs open kinetic chain, comparisons of pulling exercises), and its influence on sprint paddle performance in surfers.

PRACTICAL APPLICATIONS

Coaches working with competitive surfers should implement strength training with their athletes, including an emphasis on developing high relative pull-up strength, as this has a strong association with sprint paddling ability. Competitive surfers perform a great deal of paddling in their structured and unstructured training sessions, therefore adding a structured strength training program is likely to greatly compliment the overall training of competitive surfers.

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