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Research Article

Effect of 8 Weeks of Grip Strength Training on Adolescent Sprint Swimming: A Randomized Controlled Trial

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ABSTRACT

Objectives: Grip strength positively correlates with faster sprint swimming performance in both master and elite level swimmers. But it remains unknown whether improving grip strength improves swim performance. Our objective was firstly to increase grip strength and secondly to determine if improved grip strength results in faster backstroke and freestyle sprint swimming performance.

Methods: Using a randomised, control trial design 26 adolescent swimmers were randomly divided into either a swimming only Control group (n=9, age 11.5 ± 1.6 y; 6 male, 3 female) or one of two grip strength training groups: Powerball (n=9, age 11.5 ± 1.6 y, 6 male, 3 female) or Stressball (n= 8, age 11.6 ± 1.6 y, 5 male, 3 female). The Powerball (Powerball and Power Gripper devices) and Stressball (Stress-ball and Skrunch ball) groups completed a grip strength training program (4x/week for 8 weeks) in addition to their normal swimming training (4 hours per week). Pre and post the training intervention, isometric grip strength was measured using a mechanical hand dynamometer (Lafayette Instrument, Lafayette, IN) while 50 m freestyle and 100 m backstroke short-course swimming time trials were also undertaken.

Results: Over 8 weeks, all groups improved their maximal grip strength with moderate to large changes (Powerball 30 ± 12%, ES=1.70; Stressball 36 ± 22%, ES=1.07; Control 35 ± 12%, ES=0.79). There were no statistically significant changes for any group in the 100 m backstroke ($P>0.05$), but significant ($P<0.05$) small improvement in the Powerball (4.1 ± 5.6%, ES=0.26) and Stressball groups (3.4 ± 3.4%, ES=0.24) during 50 m freestyle. There were no significant between group changes for any variable.

Conclusions: Grip strength improved but failed to improve 100 m backstroke performance. Improving grip strength may contribute towards faster 50 m freestyle swim performance in this adolescent age group.

INTRODUCTION

Regarding actual surface-swim performance, a swimmer's ability to reach high speeds is determined by the ability to cover a long distance per stroke, while stroking at maximum frequency [1]. Short sprint swimming (50 – 100 m) requires a continuous high stroke rate and stroke length throughout the race [2,3]. The ability to cover a long distance per stroke demonstrates a greater propulsive efficiency [4] of a swimmer to reduce drag [5] and stroke length has been reported as the best discriminative factor for swim velocity [6].

Handgrip strength results from the forceful flexion of all hand joints (finger joints, thumbs, and wrists) and is measured as the maximum voluntary force that subjects are able to exert under normal biokinetic conditions. There are 35 muscles involved in grip strength which is created by the muscles involved in the flexor mechanism of the hand and forearm, whereas stabilization of the wrist occurs from the extensors of the forearm [7]. In addition to resistance training, handgrip strength is known to be affected by a number of factors such as age, body size, and gender [8].

Maximising propulsive force is a key factor in competitive swimming performance and isometric handgrip strength has been positively correlated with swimming performance [9]. Correlations are stronger in shorter compared to longer swimming races and are stronger for freestyle compared to other strokes [10]. In a recent review, giving mixed results Cronin et al., [11] found that stronger correlations were ob-

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served between hand grip strength and sprint swim performance (r= 0.18 - 0.82 distance ≤ 100 m) in young and teenager swimmers. It is unknown whether isometric hand grip strength is a proxy for overall strength, which in turn itself could be related to swimming performance. To date, there have been no studies investigating whether improved grip strength results in an improved sprint swimming performance. Therefore, our first objective is to design a strength training program to improve grip strength, in order to fulfil our main objective of assessing whether improved grip strength results in improved adolescent swim performance.

METHODS

Twenty-six competitive (exercising 3.5 ± 1.5 hours/week) adolescent swimmers (17 males, 9 females; age 11.5 ± 1.5 years; 50 m Freestyle: 196 ± 86 FINA points) from the South Island of New Zealand volunteered for this study. FINA (Fédération internationale de natation) points are a way of comparing swimmers' performances to the current World Record, the higher the points value the closer a swimmer's performance is to an event's World Record. All procedures performed were in accordance with the ethical standards of the University of Canterbury Human Ethics Committee (approval number HEC2018/14). Informed consent was obtained from all individuals and respective guardians.

A randomized placebo-controlled, single blinded (researchers only) trial design was used to assess the impact of 32 five minute sessions of grip strength training on 50 m freestyle and 100 m backstroke short-course swimming performance.

Baseline isometric grip strength testing was performed 48 hours prior to the commencement of the strength training intervention. Using isometric grip strength, swimmers were triplicate-rank-matched by the lead investigator, and using a draw were randomly allocated into a treatment (Powerball), placebo (Stressball) or control (Swim only) group. The swimmers were told that it was a grip strength training study using different training implements; however they were not told what intervention would be expected to be the most effective treatment. The prescribed training was performed four times a week over the next eight weeks. Swimmer characteristics are provided in Table 1. After completing eight weeks grip training, all swimmers performed post grip strength and swim testing.

In conducting isometric grip strength testing, swimmers held an adjustable mechanical dynamometer (Lafayette Instrument, Lafayette, IN) in their hand with the arm held straight and maximally squeezed for three seconds. The maximum strength of three attempts for each hand was recorded [12], with the maximal grip strength of the dominant hand used in the analysis. Grip strength familiarisation testing was undertaken one week prior to the baseline data collection.

Following strength testing, participants undertook their regular swimming warm up for 15 min, before reporting for a 100 m backstroke time trial. Swimmers were stop-watched timed (Finis 3x100 m stopwatch, Livermore, CA) by three experienced timers with the median of the three times taken. After 10 minutes recovery, swimmers performed a maximal 50 m freestyle time trial.

During the training intervention, the Control group only completed their scheduled swimming only training sessions. Whereas, in addition to swim training, the Powerball group trained with a 7.5 cm diameter powerball spinner gyroscopic hand strengthener (Powerball 280 Pro, Thurles, Ireland) as well as an adjustable 5 – 50 kg Power Gripper (RPM Sports, Thurles, Ireland) device (Table 2); and the stressball group trained with a foam stressball, and a power skrunch ball (RPM Sports, Thurles, Ireland) (Table 3).

Data were analysed in Excel for Mac version 16.16.22 and reported as mean ± standard deviation, with 90% confidence limits also displayed. Between-group using independent samples t-tests and within-group changes using paired

Table 1. Group descriptive data

Group	Age (years)	Males	Females
Powerball (n=9)	11.5 ± 1.6	6	3
Stressball (n=8)	11.6 ± 1.6	5	3
Control (n=9)	12.1 ± 2.3	3	6

Table 2. Powerball Group training program

Week	Powerball (Session 1 & 3)	PowerGripper (Session 2 & 4)		
	Time (s)	Reps (#)	Sets (#)	Resistance (%)*
1	45	15	2	60
2	60	15	3	60
3	75	12	2	70
4	90	12	3	70
5	105	9	2	80
6	120	9	3	80
7	135	6	2	90
8	150	6	3	90

** Resistance individualised based on baseline grip strength measurement*

Table 3. Stressball Group training program

Week	Skrunch ball (Session 1 & 3)		Stress ball (Session 2 & 4)		
	Time (s)	Tempo	Reps (#)	Sets (#)	Tempo (Sec in and out)
1	45	Fast	15	2	Fast
2	60	Fast	15	3	Fast
3	75	Fast	12	2	1
4	90	Fast	12	3	1
5	105	Fast	9	2	2
6	120	Fast	9	3	2
7	135	Fast	6	2	3
8	150	Fast	6	3	3

Table 4. Pre and post strength and swimming performances, mean ± sd with (90% CI)

	Powerball (n=9)	Stressball (n=8)	Control (n=9)
Grip strength			
Pre (kg)	22.8 ± 4.2 (20.5 – 25.1)	24.8 ± 7.4 (20.5 – 29.1)	24.5 ± 9.6 (19.2 – 29.8)
Post (kg)	29.3 ± 3.4 (27.4 – 31.2) #	32.6 ± 7.4 (28.3 – 36.9) #	32.4 ± 10.6 (26.6 – 38.2) #
ES	1.70	1.05	0.78
Interpretation	Large (stronger)	Moderate (stronger)	Moderate (stronger)
100m Backstroke			
Pre (s)	102.22 ± 13.29 (94.93 – 109.51)	101.97 ± 10.95 (95.60 – 108.34)	108.14 ± 16.54 (99.07 – 117.21)
Post (s)	102.51 ± 13.84 (94.92 – 110.10)	102.21 ± 11.51 (95.52 – 108.90)	108.75 ± 17.00 (99.43 – 118.07)
ES	0.02	0.02	0.04
Interpretation	Trivial	Trivial	Trivial
50m Freestyle			
Pre (s)	43.97 ± 8.74 (39.18 – 48.76)	42.04 ± 6.92 (38.02 – 46.06)	41.99 ± 9.17 (36.96 – 47.02)
Post (s)	41.93 ± 6.99 (38.10 – 45.76) *	40.49 ± 5.95 (37.03 – 43.95) *	40.58 ± 7.29 (36.58 – 44.58)
ES	0.26	0.24	0.17
Interpretation	Small (faster)	Small (faster)	Trivial

* *within group change from pre to post test (p<0.05)*

\# *within group change from pre to post test (p<0.001)*

samples t-tests were calculated with p values obtained, the threshold for statistical significance was set at (P<0.05). Cohen's effect sizes (d) were used to evaluate the magnitude of pre to post change for each variable with effect sizes interpreted using Hopkins' thresholds of 0.2, 0.6, 1.2 and >2.0 for small, moderate, large and very large [13].

RESULTS

Changes in grip strength and swimming performance over the 8-week training intervention are presented in Table 4. Statistically there were no between group changes for any variable. Of note, all groups improved their grip strength, with a large strength increase (30 ± 12%) in the Powerball group and moderate strength increases in the Stressball (36 ± 22%) and Control groups (35 ± 12%). No group improved 100 m backstroke performance. In contrast to 100 m backstroke, we did find a statistically significant improvement in the 50 m freestyle performance albeit of a small magnitude in the Powerball (-4.1 ± 5.6%, d=0.26, p=0.04) and Stressball (-3.4 ± 3.4%, d=0.24, p=0.02) groups.

DISCUSSION

The overall objective of this study was to investigate if improved grip strength would lead to improved sprint swimming performance. In order to achieve this objective it was first necessary to improve grip strength. Using two training groups we were able to successfully improve grip strength utilizing four training implements and progressively increasing volume / intensity eight week training programs. It was somewhat surprising to see the control group also increase their grip strength considerably but to a lesser magnitude of the intervention groups. Despite grip strength familiarisation testing being undertaken one week prior to the baseline data collection, the swimmers had limited experience with this type of testing.

Many studies have reported correlations between grip strength and sports performance, and several studies have shown positive correlations with sprint swimming performance [9,10,14]. Yet, this is the first study to investigate if improved grip strength results in faster swimming performance. Our results showed no improvement in 100 m backstroke performance across any of the groups. All swimmers undertook their normal squad training throughout the study, and the training period coincided with a general aerobic swimming block. There may have been a build-up of training fatigue across the study period which would have masked any fitness gains which would only be realised once the residue fatigue dissipated during a taper period. In hindsight, incorporating a measure of recovery such as the Total Quality Recovery scale could have helped with our interpretation. Nevertheless, all groups displayed a similar performance decrement therefore we can only conclude that improved grip strength does not improve 100 m backstroke swimming performance.

With 50 m freestyle performance, we did find a statistically significant improvement albeit of a small magnitude in the Powerball and Stressball groups. It is important to consider the level of improvement in relation to the sporting event and what the expected rate of improvement would be over a similar 8 week time period. If we presumed that for instance the level of improvement was maintained for the whole year, swimmers in the powerball group would be ~25% faster, this obviously is a huge amount amount but it still doesn't give us insight into the expected rate of improvement in adolescent swimmers. Fortuitously, our lab has recently looked into improvement and variability of adolescent swimming performance by age albeit in backstroke. Nevertheless, if we assume 50 m backstroke performance has a similar progression as 50 m freestyle, a swimmer would expect a mean yearly improvement based on their age. Across the early competitive swimming years (ages 8–10 years old) it is not uncommon to improve close to 10% in a year. However, during the middle years (ages 11–14 years old) an improvement of ~5% is more realistic. While in the later years (15–18 years old) improvements of only 1–2 % are to be anticipated. It has previously been reported by Stewart & Hopkins, that factors that change performance time by as little as 0.5% will affect the placing of a top junior swimmer [15].

Various strength, anthropometric, and body composition variables have been used in sports to evaluate the effects of training. Researchers have long recognized the importance of quantifying competition-to-competition variability in swimming performance. This enables estimation of the smallest worthwhile performance change, which in turn helps coaches to define realistic goals and training methods [16]. Our findings, showing improvements for 50 m freestyle of 3 – 4% in only 8 weeks being well above the estimated yearly rate of improvement and also above the 0.5% threshold likely to affect the placing of a top junior swimmer we would recommend that improving grip strength is likely to contribute towards faster 50 m freestyle swim performance in this adolescent age group.

Future studies should investigate alternative exercises to improve backstroke performance. While there is still a need to assess the effect of improved grip strength on butterfly and breaststoke performance, as well as investigating a range of distances.

CONCLUSIONS

Eight weeks of grip strength training improved the strength of adolescent swimmers. However, this improved strength had no benefit on 100 m backstroke swimming and may have only contributed towards a small improvement in 50 m freestyle. Yet, this small improvement is likely practically beneficial for adolescent 50 m freestyle swimmers. In conclusion, grip strength training should form part of a training program, where the additive effect of other exercises will result in a greater overall strength improvement and a more effective transfer to swimming performance.

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Conflicts of Interest

The authors declare no conflict of interest.

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