Swimming Performance Evaluation in Athletes Submitted to Different Types of Strength Training

Edvander Bertoleti Junior¹, Felipe J. Aidar¹,²,³,⁴, Raphael Fabricio de Souza²,³,⁵, Dihogo Gama de Matos¹,⁴, Milena Barbosa Camara⁶,⁷, Adriane Aline Batista Gomes⁴, Osvaldo Costa Moreira⁸,⁹, Breno Guilherme Araújo Tinoco Cabral⁷,¹⁰, Nuno Domingos Garrido¹

¹Tras os Montes e Alto Douro University, Vila Real, Portugal; ²Department of Physical Education, Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, ³Graduate Program in Master's level in Physical Education, Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, ⁴Group of Studies and Research of Performance, Sport, Health and Paralympic Sports - GEPEPS, the Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, ⁵Racing Club at the Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, ⁶Portiguar University, Natal, Brasil, ⁷Laboratory of Human Movement Federal University of Rio Grande do Norte – UFRN, Natal, Brasil, ⁸Institute of Biological Science and Health – Federal University of Viçosa – Florestal Campus – Florestal – Minas Gerais – Brazil, ⁹Institute of Biomedicine – University of Leon – León – Spain, ¹⁰Federal University of Rio Grande do Norte – UFRN, Natal, Brasil

ABSTRACT

Junior EB, Aidar FJ, de Souza RF, de Matos DG, Camara MB, Gomes AAB, Moreira OC, Cabral BGAT, Garrido ND. Swimming Performance Evaluation in Athletes Submitted to Different Types of Strength Training. JEPonline 2016; 19(6):1-9. The purpose of this study was to compare the effects of a traditional strength training exercise, a training tether made of rubber attached to a belt around the swimmer’s waist in the water, and training only in the water without additional strength training on the performance of the 25 m and 50 m freestyle in young athletes. The subjects consisted of 24 male athletes 15 to 16 yrs of age. They were
divided into 3 groups: (a) 7 swimmers tethered by a rubber device while in the water (RW); (b) 7 swimmers who did strength training (ST) program; and (c) 7 swimmers who comprised the control group (CG). The findings indicate that there was no difference in the post-test responses between the group that trained while tethered to the rubber device and the group that engaged in a traditional strength training program. But, there were differences in both groups that engaged in strength training compared to the control group at both time points (pre- and post-test). Hence, it is reasonable to conclude that both strength training methods used in this study tended to promote improvements in speed, especially for shorter distances.

**Key Words**: Swimming, Training, Strength Training

**INTRODUCTION**

Muscle strength can be defined as the maximum force that muscles produce to create a specific pattern of movement that is often defined by a certain speed (4). In recent decades, the muscle strength, in particular, has been acknowledged as a key component in the fitness of swimmers. Hence, training for muscle strength is considered an important part of most training programs in competitive swimming (7). In fact, Aspenes and colleagues (1) indicate that the increase in upper body muscle strength is correlated with swimming speed.

Therefore, specifically, an improvement in the strength of the muscles of the upper limbs can result in an increase in the propulsive actions that allow for a faster swimming time, especially over short distances (14). The primary method of increasing muscle strength is by strength training (ST), which is used to improve muscle performance. If properly supervised and practiced systematically, strength training produces important intracellular adaptations that result in muscle hypertrophy (5), increased maximum strength, power, and endurance (17).

Applied in training swimmers, both in and out of the water, the purpose of a strength training program is to increase muscle strength by overloading the muscles used in swimming (7). This point is not new, given that strength training programs have been used by swim coaches for many years. Coaches and athletes alike believe that strength training is an integral part of the preparation of competitive swimming. It is so important that numerous variations in the methods applied to strength training for swimmers have been suggested. Interestingly, though, the benefits that result from strength training depend on the manipulation of several factors, such as the correct selection of the means (exercises), methods (implementation of exercises), organization (periodization), and its application (7).

However, more often than not, there is a lack of clarity regarding the best combination of abovementioned factors for the development of strength training for swimmers. Perhaps, that is why strength training prescription models for this population of athletes are not well established. In addition, the results of experiments available in the literature regarding the increase in muscle strength and swimming performance still remain inconclusive (5). Thus, the purpose of this study was to compare the effects of a traditional strength training program to the use of a tethered rubber device connected to a swimmer in the water and training only in water without the means of additional strength training on the performance of a 25 m and a 50 m freestyle swim in young male athletes.
METHODS

Subjects
The subjects consisted of 24 male athletes 15 to 16 yrs of age. All subjects were federated swimmers and participants in more than 3 yrs of competitive swimming and had participated in national competitions. They were also registered in the Water Sports Federation of Mato Grosso do Sul (FEDAMS) in the Midwest region of Brazil.

This study was conducted according to ethical standards in sport and exercise science research, and the protocol was fully approved by the Ethics Committee in Research with Human Beings. Before participation, approved procedures, risks, and benefits were explained to all swimmers. Their parents gave informed consent, as part of their sport needs, which is consistent with institutional policies for use by the human subject search. Subjects were excluded if they reported any musculoskeletal injury and/or exercise restriction in the three months prior to the study getting underway.

All subjects were informed about the study and signed the authorization form (informed consent) according to Resolution 466/2012 of the National Ethics Committee - CONEP, the National Health Council, in accordance with the ethical principles expressed in the Declaration of Helsinki (1964, reformed in 1975, 1983, 1989, 1996, and 2000), the World Medical Association.

Procedures
The study was conducted in a semi-Olympic pool (25 m) with a temperature between 26° and 27° in a club (private) in the city of Campo Grande, Mato Grosso do Sul State, Brazil. For the marking of time in agility and speed tests, a digital stopwatch (Casio Sports Stop Watch HS-50W; Cassio, Japan) was used.

The maturational level of the subjects was obtained using the Tanner Maturation Scale (21), which uses a ranking based on two items: Pubic hair (P); and Genitals (G). Each of the items was subdivided into 5 phases: (a) Stage 1 indicates the pre-pubertal state of development, P-1 or G-1; (b) Stage 2 shows the initial development of each feature; (c) Stages 3 and 4 indicate the continued maturation of each feature that are more difficult to assess; and (d) Stage 5 (P-5 and G-5) indicates the adult or mature state.

This study connected the athletes to a tethered rubber device with lengths of 3 m, following the dimensions described in Table 1.

Table 1. Rubber Diameter (mm).

<table>
<thead>
<tr>
<th>Size</th>
<th>200</th>
<th>201</th>
<th>202</th>
<th>203</th>
<th>204</th>
<th>205</th>
<th>206</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Diameter (mm)</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
<td>6.0</td>
<td>6.0</td>
<td>8.0</td>
<td>8.0</td>
<td>16.5</td>
</tr>
<tr>
<td>External Diameter (mm)</td>
<td>5.5</td>
<td>5.5</td>
<td>8.0</td>
<td>9.0</td>
<td>11.5</td>
<td>12.0</td>
<td>13.5</td>
<td>18.0</td>
</tr>
</tbody>
</table>
The subjects were randomly divided into 3 groups: (a) 7 swimmers who were tethered by a rubber device while in the water (RW); (b) 7 swimmers who did a traditional strength training (ST) program; and (c) 7 swimmers who comprised the control group (CG).

The Tanner Maturation Scale (a scale of physical development in children, adolescents, and adults) was used to assess the subjects' maturation. Given that the subjects were in the phase of puberty (that associates with various hormone levels), it was important to analyze the degree of maturation of the sample to better understand the influence of the treatment variables (3).

**Familiarization**
The subjects were introduced to two familiarization sessions that involved: (a) the aquatic tests; and (b) the strength training procedures (13).

**Assessments**
The swimming performance test procedures, strength, and power were tested in three stages: (a) at the beginning of the program (T1); (b) after 4 wks of combined strength training and aquatic training (T2); and (c) after 8 wks of training (T3). All groups were assessed at the same times.

**Swimming Training**
During 8 wks of training, all subjects completed 40 water training sessions (5 sessions·wk⁻¹). The training in the swimming pool consisted of the following structure: (a) 1200 m of heating; (b) 500 m educational exercises; (c) 300 m speed drills; and (d) 1,800 m, which was the main part of subjects' training (with 500 kicks and 200 m release).

**Strength Training**
In addition to the regular swim training sessions in the pool, the 7 swimmers who were tethered by a rubber device while in the water (RW) were subjected to 8 wks of tethered swimming (at 2 sessions·wk⁻¹ on Tuesday and Friday of each week). The RW subjects were supervised by two experts in strength training and the team coach. The RW exercise training consisted of 3 series of which each was composed of 2 series of 30 secs of application and 10 secs with a 2-min rest (according to Figure 1).

![Figure 1. Situation in the RW Group, Performing the Work Force during the Exercise Program.](image_url)
The ST group consisted of 3 sets of 10 repetitions for each exercise at a load of 60% to 80% of maximum (15), where the concentric phase was held in time (sec) and two eccentric times (sec). The program was composed of the horizontal leg press, bench press, Felxão Knees, Puller ahead, Development ahead and triceps rope, all made in a Multi Power type module of the Venus brand (Venus, Brazil).

**Intensity Control**

It was used for security activities Subjective Perception Scale of Borg effort, the use of scale in their levels of "14 to 17" points (2). The Scale was presented to the subjects during the familiarization with the activities that resulted in a numerical value on the scale corresponding to their overall perception of effort at that moment. The values were fixed in familiarization to the desired values and were adjusted during the intervention.

**Performance Swimming**

The evaluation process was conducted in a 25 m pool deck. The run time was determined by two trained individuals with a stopwatch. The average of two readings was obtained for each test. After a heating of 500 m crawl all swimmers made a maximum effort during the 25 m and 50 m front crawl with a 2-day interval between them. All swimmers performed two maximal tests of the 25 m and 50 m, with a period of 15 min of passive recovery between the two tests and the average value was used for analysis (6).

**Test 1RM**

Regarding the subjects’ strength training, the load was determined by the 1RM test of the upper and lower limbs (10). The subjects performed 3 to 5 min of light activity that involved the tested muscle group, which was followed by 1 min of light stretching and warming up with 8 repetitions at 50% 1RM and, then, 3 repetitions at 70% 1RM. After a 5 min interval, if it was necessary, 0.4 to 5 kg was added totaling 3 to 5 attempts, which was recorded as the maximum load that was lifted in a single movement.

**Statistical Analyses**

Descriptive statistics was carried out to obtain measures of central tendency and mean ± standard deviation. Statistical analysis was performed by the computer package Statistical Package for Social Sciences (SPSS) version 20. To check the normality of the variables, the Shapiro-Wilk test was used, given the sample size. For evaluating the performance in the water between the groups, a one way ANOVA with Tukey. Foi followed by post hoc analysis was done. The statistical significance level was set at P<0.05. To check the size of the effect, Cohen $f^2$ test was used of which the adopted cut off points were from 0.02 to 0.15 as small, 0.15 to 0.35 as average, and higher than 0.35 as large.

**RESULTS**

The results of the aquatic performance before and after the test are shown in Tables 2 and 3. There is no difference in the post-test responses between the group that was tethered by a rubber device while in the water (RW) and the group that engaged in traditional strength training. We observed differences in training methods in both the RW and ST groups compared to the control group at both time points (pre- and post-test). It was found that there
was no difference in the pre- and post-test between groups, whether they trained with the tethered rubber device or via traditional strength training or in the control group.

Table 2. Data of Athletes Submitted to Strength Training via a Tethered rubber Device, Traditional Strength Training, and the Control Group Regarding Water Performance in the 25 m Freestyle.

<table>
<thead>
<tr>
<th></th>
<th>25 m</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>$f^2$ de Cohen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>13.15 ± 0.54</td>
<td>13.13 ± 0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber Band</td>
<td>13.10 ± 0.65</td>
<td>12.70 ± 0.46*</td>
<td>0.158</td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>13.12 ± 0.64</td>
<td>12.85 ± 0.38*</td>
<td>0.034</td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05

Table 3. Details of Athletes Submitted to Strength Training with the Tethered Rubber Device, Traditional Strength Training, and the Control Group Regarding Water Performance in the 50 m Freestyle.

<table>
<thead>
<tr>
<th></th>
<th>50 m</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>$f^2$ de Cohen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>27.55 ± 0.54</td>
<td>27.51 ± 0.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber Band</td>
<td>27.50 ± 0.75</td>
<td>27.13 ± 0.72</td>
<td>0.042</td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>27.52 ± 0.44</td>
<td>27.14 ± 0.64</td>
<td>0.013</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

Most athletes benefit from strength training. The increase in muscle strength, power, and endurance help with learning sport skills and in performing sports. Both strength training methods used in the present study tended to promote improvements in speed, especially for the shorter distance (25 m freestyle). The strength training programs had no significant influence on time at the 50 m freestyle.

Perhaps, part of the explanation for the fact that the strength training programs had no effect on the time at 50 m freestyle is that subjects in both strength training groups simply could not generate a greater driving force while minimizing the drag in the water. This perspective may be explained by the lack of improvement in the subjects' physical condition. Other considerations include the subjects' failure to improve their biomechanical performance, body composition (11), ankle flexibility (9), strength of lower limb muscles, and overall swimming skills (8).

It is interesting that many athletes and coaches do not accept strength training work to improve their swimming technique and time. Yet, in general, it is clear (i.e., aside from the athletes' swimming skills), the stronger the athletes the better they performance. Thus,
studies on strength training in young swimmers have been presented as important in the improvement of their strength and water performance (16).

Corroborating our findings, Strass (19) found improvement from 0.04 to 0.08 m·s⁻¹ at medium speed of adult swimmers at a distance of 50 m after participating in strength training with weights. This demonstrates the importance of strength in swimmers. In agreement, Hawley and colleagues (8), in a study with 22 swimmers found significant relationships between sprint-swim speed and mean power of the arms and legs. Marinho (12) and Sharp et al. (18) have also demonstrated a high correlation between power and speed (12,18,20).

Tanaka and colleagues (20) evaluated the value of dry-land resistance training on front crawl swimming performance. During a 14-wk competitive swimming season, the swimmers were divided into a swim training group (SWIM) and a combined swim and resistance training group (COMBO). The COMBO engaged in 8 wks of resistance training program 3 d·wk⁻¹. The authors reported that no change in distance per stroke was observed throughout the course of training, and no significant differences were found between the groups in any of the swim power and swimming performance tests. The lack of a positive transfer between dry-land strength gains and swimming propulsive force may be due to the specificity of training. Yet, the specificity of the tethered device did the present study did result in a difference in the post-test responses between the groups.

CONCLUSION

The findings indicate that there was no difference in the post-test responses between the group that trained while tethered to the rubber device and the group that engaged in a traditional strength training program. But, there were differences in both groups that engaged in strength training compared to the control group at both time points (pre- and post-test). Hence, it is reasonable to conclude that both strength training methods used in this study tended to promote improvements in speed, especially for shorter distances.

Address for correspondence: Felipe José Aidar - Cidade Universitária Prof. José Aloísio de Campos - Avenida Marechal Rondon, s/n Jardim Rosa Elze - CEP 49100-000 - São Cristóvão/SE - (79) 2105-6600, (79) 2105-6537, Email: fjaidar@gmail.com

REFERENCES


**Disclaimer**
The opinions expressed in JEPonline are those of the authors and are not attributable to JEPonline, the editorial staff or the ASEP organization.